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Taxonomic diversity of marine planktonic ‘y-larvae’ (Crustacea: Facetotecta) from a coral reef hotspot locality (Japan, Okinawa), with a key to y-nauplii

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Abstract. The enigmatic ‘y-larvae’ (Thecostraca: Facetotecta) are microscopic marine planktonic crustaceans that were discovered more than a century ago, yet to this day their adults remain unknown. Despite occurring locally in large diversities, and therefore presumably being of ecological importance, only 17 species have been described globally, rendering it practically impossible to identify any y-larval specimen from any locality. The fact that species have been based on different life stages (nauplii and/or cyprids) further hampers identification. Y-larvae include many forms with planktotrophic (feeding) nauplii and even more with lecithotrophic (non-feeding) nauplii. At one coral-reef locality on the shore of Sesoko Island (Okinawa, Japan), extensive fieldwork in 2018 and 2019 confirmed an enormous taxonomic diversity of y-larvae there. Here, we present morphological diagnoses and an identification key for 34 lecithotrophic y-naupliar types (or morphospecies), which will correspond minimally to the same number of species when described. As a temporary measure, all are referred to by alphabetical parataxonomic designations, except for three that have been formally described already within the genus *Hansenocaris* Itô, 1985. To this should be added an additional 7–9 planktotrophic y-naupliar morphospecies, which are only treated briefly. Most often, y-larval taxonomy has been based on the cyprid stage, but the large morphological diversity of y-nauplii suggests that nauplii are at least as important for taxonomy. Lecithotrophic y-nauplii display a multitude of body shapes, the form-evolution of which is discussed here with reference to a recent molecular phylogeny of Facetotecta partly based on material from the same site. An indirect estimate of the relative abundances of all 34 lecithotrophic y-naupliar morphospecies is presented, based on laboratory-reared final-instar specimens. This treatment is intended as a step towards a proper taxonomy and a revised classification of Facetotecta, which will involve detailed descriptions of both nauplii and cyprids. Until such work progresses, the present overview of the y-naupliar fauna of a single Okinawan locality known to be a hotspot of y-larval diversity is offered as a baseline for further surveys of Facetotecta elsewhere in the Indo-West Pacific and beyond.

Keywords. Coral-reef plankton, nauplius, laboratory rearing, parataxonomy, dichotomous key, microphotography, SEM.

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Introduction

‘Y-larvae’ – only known as larvae, yet occurring abundantly

The enigmatic ‘y-larvae’ (Thecostraca: Facetotecta) are microscopic marine planktonic crustaceans that were discovered more than a century ago, yet to this day remain known only by their larvae (nauplius y and cypris y) and a slug-like, putative juvenile instar (ypsigon) (Hansen 1899; Bresciani 1965; Glenner *et al.* 2008; Dreyer *et al.* 2023b). Y-adults and their manner of producing and liberating larvae still await discovery. It is thought that the ypsigon may be an infective stage, with the adults being endoparasitic in as yet unknown hosts; such a life cycle would be comparable to that of Rhizocephala, parasitic barnacles that infect other crustaceans (Glenner *et al.* 2008; Pérez-Losada *et al.* 2009). In fact, Facetotecta are firmly established, along with Ascothoracida, as relatives of Cirripedia (barnacles) within Thecostraca, based on both morphological and molecular data (Grygier 1985; Pérez-Losada *et al.* 2012; Petrunina *et al.* 2013). Their incompletely known life cycle remains a remarkable mystery in marine biology, and so does the enormous diversity of y-larvae documented from certain East Asian localities (Dreyer *et al.* 2023b).

Y-larvae have been found worldwide in marine plankton at depths of 0–5900 m at both coastal and offshore sites, but usually in small numbers (Dreyer *et al*. 2023b). The first significant report of y-larvae was Hansen’s pioneering treatment, which was based on only 24 naupliar specimens collected over a vast area of the Atlantic Ocean (Hansen 1899). Other reports involving modest or large numbers of specimens have been few, such as the hundreds of y-nauplii reported from Canada’s Bay of Fundy and the Halifax area by Fish & Johnson (1937; fide Schram 1972), 95 y-nauplii from Norway’s Oslofjord (Schram 1970, 1972), 102 y-nauplii from southern Italy (Belmonte 2005) and more than 400 y-nauplii and y-cyprids from the Russian White Sea (Kolbasov *et al.* 2021b) (full summary of occurrences: Dreyer *et al.* 2023b). Even Itô’s ground-breaking taxonomic and morphological investigations of y-larvae in Japanese waters (Itô & Ohtsuka 1984; Itô 1984, 1985, 1986a, 1986b, 1987a, 1987b, 1989, 1990a, 1990b, 1991; Itô & Takenaka 1988) were based on a limited number of specimens (Olesen *et al.* 2022; Dreyer *et al.* 2023b).

The present study stems from the reported occurrence of large quantities of y-larvae in shallow water at Sesoko Island (Okinawa, Japan), supposedly involving “more than 40 facetotectan ‘species’” (Grygier 1991; Glenner *et al.* 2008: 4). Renewed fieldwork at Sesoko Island during two seasons in 2018 and 2019 resulted in the collection of almost 10 000 y-larvae (Olesen *et al.* 2022), thereby firmly establishing this site as a shallow-water hotspot for y-larvae (Fig. 1). The first image-vouchered molecular phylogeny of y-larvae was presented in Olesen *et al.* (2022), but this preliminary work was limited to two described species and three new y-naupliar morphospecies. This was later expanded to a multilocus phylogeny involving both mitochondrial and nuclear genes, based on more than 200 image-vouchered specimens of y-nauplii (Dreyer *et al.* 2023a). This showed facetotectan phylogeny to be remarkably complex, with numerous smaller and larger clades separated by molecular distances comparable to those encountered in other crustacean taxa that have significantly more elaborate internal classifications involving multiple genera and families. Furthermore, molecular evidence was found confirming the existence of dozens of y-larval ‘species’ collected primarily from Sesoko Island and denoted for temporary convenience by an alphabetical parataxonomy (Dreyer *et al.* 2023a). It is overwhelmingly clear that the current internal classification of Facetotecta, with all named species being included in one family with a single genus (Hansenocarididae Olesen & Grygier, 2022 and *Hansenocaris* Itô, 1985), is overly conservative. It is also evident, however, that the treatment of y-larval diversity hitherto in the scientific literature has been too scattershot to permit a meaningful taxonomic revision.

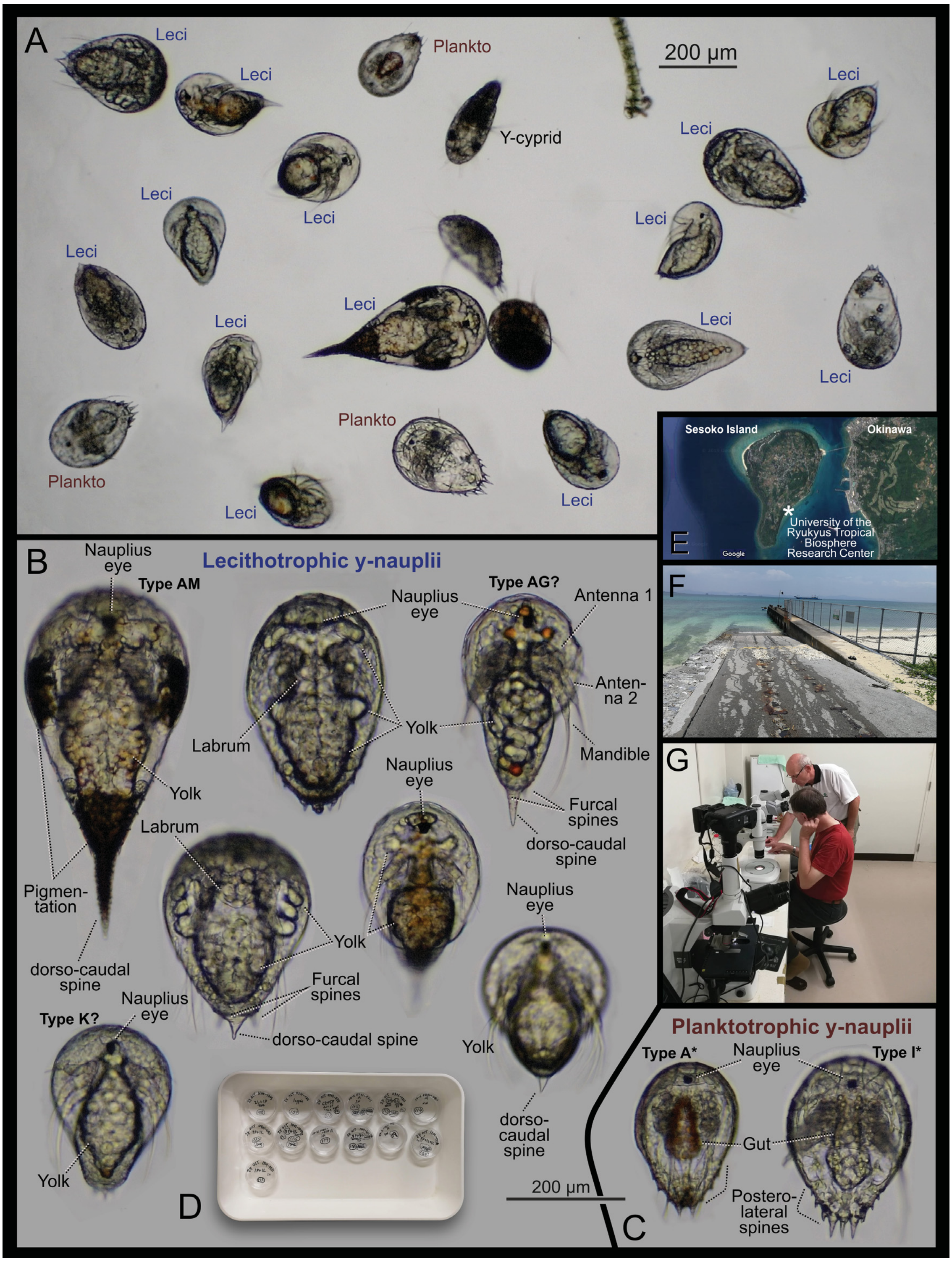

Fig. 1. Field work to collect y-larvae (Facetotecta) at Sesoko Island (Okinawa, Japan) in 2018 and 2019. **A**. Example of newly collected y-nauplii (19 specimens) and y-cyprids (1 specimen). **B**. Seven lecithotrophic y-nauplii showing internal yolk and pigment, too early in development to be identified except for a specimen of Type AM and possible specimens of Types K and AG. **C**. Two common morphospecies of planktotrophic nauplii, Types A* and I*. **D**. Tray with code-labelled petri dishes used for rearing. **E**. Sesoko Island. **F.** Pier of Sesoko Station. **G**. Sorting and photography of y-larvae in the lab. A–C from Olesen *et al.* (2002).

Para-taxonomy or formal taxonomy? Nauplii or cyprids? Morphology or molecular data?

The taxonomy of Facetotecta is in a state of confusion. Several parallel, incompatible, and severely incomplete systems are currently being used to address y-larval diversity (Olesen *et al.* 2022; Dreyer *et al.* 2023b).

A parataxonomy of y-larvae began when Hansen recognized five forms in the Atlantic as Nauplius y I–V (Hansen 1899), and up until this day an assortment of y-naupliar 'types' have been designated by Roman numerals I–XII by various authors. Some planktotrophic y-nauplii were named 'Pacific Type I' (Itô 1986a), and Watanabe *et al.* (2000) started a new parataxonomic series by combining Roman numerals with the name of a collecting site (e.g., 'Manazuru Type I', 'Manazuru Type II'). An alphabetical system ('Type A*' to 'Type AH*') was adopted provisionally by Dreyer *et al.* (2023b) for y-naupliar morphospecies mainly from Okinawa and Taiwan. The current parataxonomic approach to naming y-larvae, which until now has often been based on a few unvouchered wild-caught nauplii, needs to be abandoned and replaced by a voucher-based method involving rearing and/or sequencing, and well-supported taxa must be embedded in a formal taxonomic setting using binomial names, type designations, etc.

Itô (1985) initiated a formal taxonomy for y-larvae by proposing the genus *Hansenocaris* (type species: *H. pacifica* Itô, 1985) to accommodate three species based on cyprid specimens that had been described or mentioned in his previous works (Itô 1984; Itô & Ohtsuka 1984). This could have provided a basis for a standardized treatment of y-larvae, but instead a complicated mixture of informal (parataxonomic) (e.g., Itô 1986a, 1987b) and formal (binomial) nomenclature ensued. Worse, at the hands of other authors the formal taxonomy soon deviated from Itô's (1985) cyprid-based approach, and the resulting mixture of larval stages among type specimens has largely prevented meaningful comparison between species. Among the 17 formally described species of y-larvae (see Olesen *et al.* 2022; Olesen & Grygier 2022), eight are based on nauplii alone, six on cyprids alone and only three, *Hansenocaris furcifera* Itô, 1989, *H. itoi* Kolbasov & Høeg, 2003 and *H. demodex* Olesen, Dreyer, Palero & Grygier, 2022, comprise matched cyprids and nauplii. Without supplementary molecular data to help confirm conspecificity, such a scattershot approach can lead to parallel and essentially unalignable taxonomies and inaccurate species counts (Olesen *et al.* 2022). Out of necessity, species descriptions of y-larvae have until now been based only on larvae, but if such descriptions are not linked to molecular barcode-type data, another parallel taxonomy could arise following the discovery of y-adults.

To forestall any further development of parallel taxonomies based on different life-history stages, it is essential, whenever possible, to base formal species descriptions of y-larvae on both nauplii and cyprids, and to obtain molecular data. In principle, this can be done most readily for species with lecithotrophic nauplii, as these can be reared to the cyprid stage in the lab, whereas this is more difficult for species with planktotrophic nauplii (Olesen *et al.* 2022; Dreyer *et al.* 2023a). The last-stage nauplius is the key stage for taxonomic work on y-larvae at places like Sesoko Island, where the facetotectan fauna is diverse, because it is (1) a developmental stage that is homologous across taxa and (2) a link between the naupliar and cyprid parts of the life cycle (Olesen *et al.* 2022). The description of *Hansenocaris demodex* in Olesen *et al.* (2022) represents the best effort so far to apply this best-practice taxonomic protocol, at least for lecithotrophic y-larvae.

Y-naupliar morphospecies and facetotectan taxonomy

The molecular approach of Dreyer *et al.* (2023a) revealed the presence of 88–127 genetic species from only a few collecting sites in East Asia, primarily, but not exclusively, from Sesoko Island (Okinawa), many of which could be readily distinguished based on naupliar morphology. However, some of the genetic species outlined in Dreyer *et al.* (2023a) are morphologically cryptic and cannot currently be clearly distinguished from each other. The next step will be to describe species formally, at least the morphologically distinct ones, following previously outlined methodology (Olesen *et al.* 2022). However, this is immensely time-consuming, and sufficient material is not yet in hand. Here, therefore, we provide a preliminary treatment using a practical ‘morphospecies’ concept, coordinated with separately published phylogenetic results (Dreyer *et al.* 2023a), as a stepping stone towards a later formal taxonomy. This concept was established prior to sequencing based on sorting hundreds of photo-ID’ed specimens, primarily 2018/2019 material from Okinawa (Olesen *et al.* 2022). The procedure resembles ‘parataxonomic sorting’, often done as the first step towards a proper taxonomic treatment whereby taxonomic specialists will later either apply existing names to the parataxonomic units or recognize them as new to science (e.g., Krell 2004). The y-naupliar morphospecies could only be presented superficially in Dreyer *et al.* (2023a), so here we present a more detailed overview of the Okinawan part of the material. For completeness, we add 11 additional lecithotrotrophic naupliar morphospecies for which no material suitable for the earlier paper’s molecular study was available, and thus present 34 lecithotrophic y-naupliar morphospecies in total. A similar treatment of the nine planktotrophic naupliar morphospecies introduced by Dreyer *et al.* (2023a) and included here in Fig. 2 is postponed.

Our y-naupliar morphospecies concept is fundamentally different from earlier y-larval parataxonomies (see above) in a number of ways. Firstly, all the y-naupliar morphospecies are based on last-stage nauplii that have been reared in the laboratory, which ensures that none of the differences between the morphospecies can be attributed to different ontogenetic stages. Secondly, the monophyly of about two-thirds of the morphospecies has been supported by molecular data (Dreyer *et al.* 2023a), which suggests taxonomic validity. Thirdly, most of the morphospecies are backed by museum-deposited voucher material, sometimes in great numbers.

Specifically, in this paper we provide the following new information for y-larvae:

1. light-microscopic photographs of 34 lecithotrophic y-naupliar morphospecies (three of which have already been formally described as species) found during field work at Sesoko Island, Okinawa, in 2018 and 2019 and earlier, in many cases showing the color patterns of live specimens;
2. brief descriptions of all 34 lecithotrophic naupliar morphospecies, based on features that are readily visible by light microscopy and on characters that are both necessary and sufficient for identification;
3. an identification key to all 34 lecithotrophic naupliar morphospecies;
4. relative abundance data for lecithotrophic y-nauplii collected during field work in 2018 and 2019.

We briefly discuss (1) the possible number of species of y-larvae at Sesoko Island based on naupliar diversity, (2) some aspects of y-naupliar evolution based on a recent molecular phylogeny (Dreyer *et al.* 2023a), (3) which y-larval life history stages to use for taxonomy and (4) the relative abundance of different lecithotrophic y-larval morphospecies at Sesoko Island.

Material and methods

Fieldwork: sampling, on-site sorting, rearing, fixation

The present work was based on extensive sampling of almost 10 000 y-larvae (nauplii or cyprids) from a shallow-water marine site at Sesoko Island (Okinawa, Japan) (26°38′09.4″ N, 127°51′55.2″ E) during fieldwork in 2018 (16–31 Oct.) and 2019 (1–20 Jun.) (Olesen *et al.* 2022) (Fig. 1), supplemented with similar material from earlier sampling (1996, 2003–2005) at the same locality (Grygier *et al.* 2019).

A detailed overview of the methodology has been published elsewhere (Olesen *et al.* 2022), but a brief summary of procedures is provided here. Plankton samples were collected with standard conical plankton nets (65–100 µm mesh size) tossed off a laboratory pier on the southeast coast of Sesoko Island. Live y-nauplii were sorted from the samples in the lab with glass pipettes under dissection microscopes and placed in groups of about five in small petri dishes (Fig. 1F–G). The present paper deals primarily

Fig. 2. Y-naupliar (Facetotecta) diversity at Sesoko Island (Okinawa, Japan). **A**. Schematic life cycle of y-larvae (modified from Itô 1991; Glenner *et al.* 2008). **B**. Overview of 34 morphospecies of lecithotrophic last-stage y-nauplii obtained by laboratory rearing of earlier-stage nauplii collected in the plankton; three of them represent formally described species while 31 remain undescribed. **C**. Nine types of planktotrophic y-larvae, of which only Type A* is treated in detail in this paper. All photos in B and C are to the same scale. Figure also used in Olesen (2004). Examples of live video of most of the y-naupliar morphospecies can be seen at https://youtu.be/er0mYLswV-c and are also deposited at Figshare.com: https://doi.org/10.6084/m9.figshare.24953568.v1.

with lecithotrophic y-nauplii, which, while alive, could be distinguished from planktotrophic nauplii relatively easily by the presence of internal yolk (generally absent in planktotrophic y-nauplii), an inflated appearance (planktotrophic nauplii being generally dorso-ventrally flattened) and the lack of a distinct row of spines along the lateral margins of the trunk region (in planktotrophic nauplii such spines are present and often quite prominent) (Fig. 1A–C). More criteria for distinguishing newly captured lecithotrophic and planktotrophic y-nauplii from each other, including some used in the identification key below, are given elsewhere (Olesen *et al.* 2022; Dreyer *et al.* 2023a).

When last-stage nauplii (LSN), distinguished by the usually black pair of developing compound eyes, appeared in a fresh sample or in the small culture dishes, these specimens were placed individually into new petri dishes to guarantee unambiguous matching with the resulting cyprids. Success in rearing newly collected lecithotrophic nauplii to the LSN stage in 2018/2019 was 8% (2018: 13%; 2019: 6%), and from newly collected nauplii to cyprids it was 4% (2018: 6%; 2019: 3%) (Table 1). Molting success from LSN to cyprid was 50% (2018: 49%; 2019: 51%) (Table 1). No data are presented for the rearing success of individual morphospecies, as newly sampled y-larvae most often could not be identified. The majority of the LSN specimens obtained in 2018 and 2019 were digitally videographed in depression slides while still alive with a Canon EOS 5D Mark IV digital camera fitted to a Nikon ECLIPSE 80i compound microscope using the HD video 50 fps mode of the camera while focusing up and down a couple of times to produce sets of images suitable for combining into a single image by means of image-stacking software (Zerene Stacker ver. 1.04).

During the field work, the exuviae of many LSNs, each left behind when the cyprid escaped, were mounted in glycerine jelly as semi-permanent slides (see Grygier *et al.* 2019) for later light microscopy. Many nauplii and cyprid specimens were preserved in 2–4% formaldehyde or 99% ethanol for further observations, especially by scanning electron microscopy (e.g., Olesen *et al.* 2022; Olesen & Grygier 2022) or for molecular study (e.g., Dreyer *et al.* 2023a). In the 'Material examined' sections below only LSNs are listed, with the exception of the planktotrophic Type A*. All material has been deposited in NHMD and also includes many pre-LSN naupliar stages as well as cyprids (see Table S1).

Different types of reference numbers used herein, especially within figures, include 'dish numbers' (if nothing is preserved but only videos are available), 'sample numbers' (JA-2018/2019-###, for preserved material), 'specimen/slide numbers' (for exuviae of older material) and/or 'museum numbers' (NHMD ######, for museum-deposited material; NHMD = Natural History Museum of Denmark).

Synonymies

The alphabetical paranomenclature for y-naupliar types used both by Dreyer *et al.* (2023a) and us overlaps with some earlier proposed designations, resulting in apparent 'homonyms'. Namely, Roman-numeral Types I, V and X (Hansen 1899; Itô 1987a) are orthographically indistinguishable from the present alphabetical Types I*, V and X, as is noted in detail in the synonymy provided for each of the latter morphospecies. Such alphabetical designations fall outside the scope of zoological nomenclature and are in any case meant to be temporary, pending the respective formal descriptions; therefore, no replacements are proposed.

The synonymies also list all appearances of the respective last-stage lecithotrophic y-nauplii in earlier literature (e.g., Itô 1991; Høeg 2005; Grygier *et al.* 2019; Olesen *et al.* 2022, 2024; Dreyer *et al.* 2023a, 2023b, 2024). Other literature (e.g., Itô 1986a, 1987a; Watanabe *et al.* 2000; Asakura 2003; Grygier 2004; Belmonte 2005; Høeg *et al.* 2014; Chan *et al.* 2021) depicts assorted lecithotrophic y-nauplii, including some from Sesoko Island, that were either early in development, superficially illustrated or collected far from the present study site (or a combination), thus preventing a convincing match with any of the current morphospecies. Among planktotrophs, only Type A* is treated herein, and some previously depicted y-nauplii from the above sources are listed in its synonymy.

	1	**2**	**3**	**4**	**5**	**6**
Y-naupliar morphospecies	**1991–2005 no. of LSN**	**2018 no. of LSN/cyprids**	**2019 no. of LSN/cyprids**	**2018 and 2019 combined no. of LSN/cyprids**	**2018 and 2019 developmental time to cyprid, (max. days)**	**2018 and 2019 mean length of LSN (µm)**
Type O*	5	16/4	50/7	66/11	11	260
Type E*	9	20/11	20/18	40/29	7	235
Type C (‘Bumblebee’)	8	15/9	25/18	40/27	9	362
Type D* (‘Big brown’)	4	20/9	15/14	35/23	8	335
Type AH*	11	13/12	18/16	31/28	8	355
Type AG*	13	18/12	9/9	27/21	6	275
Type K	5	26/6	1/0	27/6	6	205
Type G	3	4/0	17/6	21/6	7	310
Type N*	1	14/8	5/0	19/8	6	230
Type AF	2	6/4	6/4	12/8	6	225
Type AD	0	3/1	7/2	10/3	8	320
Type W	1	4/3	5/5	9/8	8	250
Type AB	3	4/3	5/4	9/7	6	225
Hansenocaris demodex	1	4/4	5/0	9/4	6	370
Type X	1	7/1	2/2	9/3	8	345
Type L	0	2/1	6/2	8/3	4	280
Type AI	2	4/3	4/3	8/6	4	225
Type M	3	2/1	4/2	6/3	6	300
Type H	0	3/1	2/1	5/2	9	350
Type F	2	1/0	4/1	5/1	5	310
Type AK	1	0/0	4/1	4/1	8	340
Type Y	4	1/0	3/0	4/0	?	380
Type AJ	0	1/0	3/0	4/0	?	350
Type B	1	0/0	3/1	3/1	11	355
Type AL	0	1/1	2/0	3/1	1	340
Type V	1	1/0	1/1	2/1	9	355
Hansenocaris cristalabri	0	0/0	1/0	1/0	?	330
Type U*	1	0/0	1/0	1/0	?	460
Type AM	0	0/0	1/0	1/0	?	420
Type AC	0	1/0	0/0	1/0	?	280
Type AN	4	0/0	0/0	0	–	–
Hansenocaris aquila	2	0/0	0/0	0	–	–
Type AO	1	0/0	0/0	0	–	–
Type AP	1	0/0	0/0	0	–	–
Total #reared LSN/cyprids	90/0	191/94	229/117	420/211		
Total sampled lecithotrophic nauplii	unknown	1515	3622	5137		
Rearing success (nauplii>LSN and nauplii>cyprid)	not reared	13% and 6%	6% and 3%	8% and 4%		
Molting success (LSN>cyprid)	–	49%	51%	50%		
No. of morphospecies (of total 34)	26	25	29			
Overlap in morphospecies between 2018 and 2019	N/A	24 of 30 (80%)				
Overlap in morphospecies during all years (1991–2005, 2018, 2019)	19 of 34 (56%)					
Correlation between number of LSN (column 4, in part) and their mean length (column 6)						-0.35075

Taxon-sorting and further microscopy

Sorting of last-stage lecithotrophic y-nauplii (LSNs) into morphospecies was based on ca 510 specimens from Sesoko Island, Okinawa (listed in Table S1), including ca 420 collected during field work in 2018 and 2019 and 90 derived from earlier field work. Single images of LSNs obtained from video clips (see above) taken in life of the 2018/2019 specimens were the primary basis for grouping specimens into morphospecies, supplemented with photographs of both the 2018/2019 and earlier slide-mounted LSN exuviae. The latter images were obtained with an inverted compound microscope (Olympus, IX83) equipped with fully automated image-stacking capability (further methodological details in Olesen *et al.* 2022) that produced z-stacks that could later be combined into single images in Zerene Stacker ver. 1.04. A few y-larvae were photographed using scanning electron microscopy (JEOL JSM-6335-F-FE) following standard procedures as outlined in Olesen *et al.* (2022).

Table S1 lists all the specimens that have been divided among the 34 morphospecies of lecithotrophic y-larvae recognized in this study and provides much ancillary information about them; key data from this complex table that will be particularly relevant to the Discussion are abstracted in Table 1. Videographic information obtained while the specimens were still alive also allowed LSNs that died without being preserved to be sorted to morphospecies like the rest. The list includes 11 morphospecies that were not included in Dreyer *et al.* (2023a) for lack of molecular data. Except for two species that have been formally described, these are denoted herein by an extension of Dreyer *et al.*'s (2023a) alphabetic parataxonomy, using the extra designations 'Type W' and 'Type AI' to 'Type AP'. Asterisks (Types A*, D*, E*, etc.) were added to the designations of morphospecies that exhibited molecular variation among specimens and might therefore represent more than one species requiring more detailed morphological study to resolve and diagnose. The glycerine-jelly-mounted LSN exuviae from earlier sampling at the same locality (Grygier *et al.* 2019), although derived from specimens that were never videographed alive, could also be sorted by similar morphological criteria as the live material (see below) except for color pattern.

To discriminate the morphospecies, all images, with associated dish and sample numbers, were assembled at the same scale on several canvasses in CorelDraw and sorted first into broad categories, then narrower ones, using characters such as size, general aspects of external morphology (labral shape and caudal spines) and coloration as the main criteria. Some morphospecies, such as the semi-vermiform nauplii of *Hansenocaris demodex* and the distinctly colored nauplii of Type C, the so-called 'Bumblebee,' had an easily recognizable morphology. Type C's late-stage sorting canvas (Fig. 3) shows all the photographic material, primarily of last-stage nauplii, but also cyprids, used to recognize the morphological distinctness of the last-stage nauplii of this rather common morphospecies. Other y-nauplii, such as those first grouped together because of a general resemblance to the unnamed lecithotrophic form depicted by Itô (1991), underwent a gradual character-based refinement that in this case finally resulted in the recognition of about six different y-naupliar morphospecies (see Discussion).

Table 1 (page 8). Lecithotrophic y-naupliar morphospecies ('Types') successfully reared during fieldwork at Sesoko Island (Okinawa) in 2018 and 2019, based on 5137 sampled lecithotrophic nauplii, with sporadic data added from earlier sampling in 1991–2005. The y-naupliar morphospecies are listed in descending order of abundance in 2018 and 2019 (column 4). Developmental time to cyprid and mean body length of last-stage nauplii (LSN) are shown, along with calculated rearing success to LSN or cyprid, degree of overlap in occurrence in both years, and correlation between morphospecies abundance and size (see Fig. 20). The data are extracted from the more comprehensive supplementary Table S1. Asterisks (e.g., Types A*, D*, E*) are added to the designations of morphospecies that exhibited molecular variation among specimens in Dreyer *et al.* (2023a) and might therefore represent more than one biological species.

Figures

The visual information presented here is designed to support the identification of lecithotrophic y-nauplii to either morphospecies or (in three cases) actual species. The overview of all the kinds of y-nauplii so far discriminated at Sesoko Island in Fig. 2 also includes planktotrophic types, detailed treatment of which is postponed for a later paper. Fig. 3 shows, as mentioned, a stage in the sorting process. The next two figures illustrate in detail some of the terminology used for planktotrophic (Fig. 4) and lecithotrophic nauplii (Fig. 5), the former being included because of their mention in the first couplet of the identification

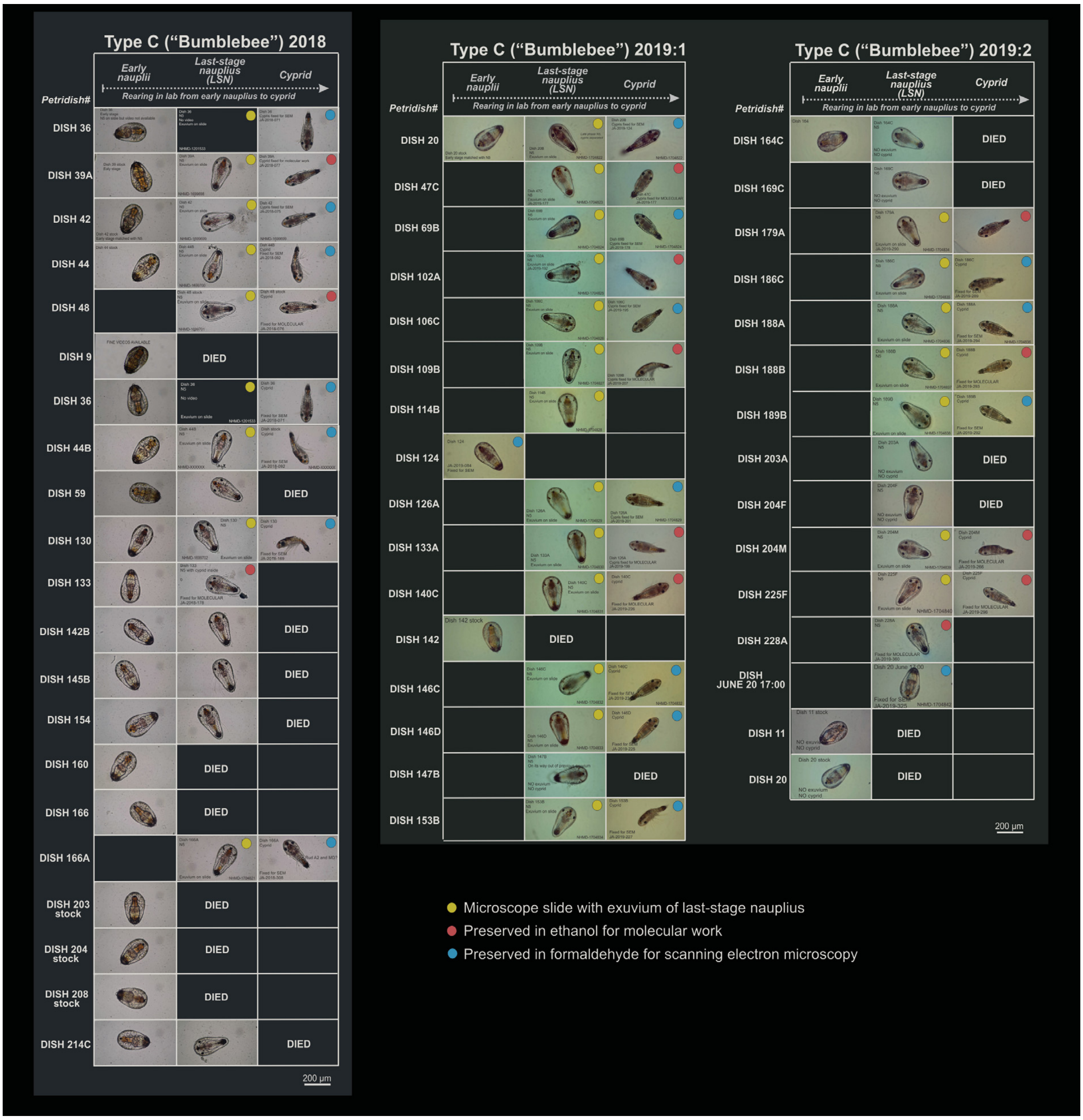

Fig. 3. Example of canvasses used to sort images of more than 500 last-stage y-nauplii obtained during field work at Sesoko Island (Okinawa, Japan) in 2018 and 2019 into morphospecies. This canvas shows different developmental stages of 52 specimens of a particularly distinctive morphospecies, Type C (nicknamed 'Bumblebee' due to its distinct color pattern), with color codes indicating each specimen's manner of preservation and storage.

key. The illustrations of LSNs of all 34 lecithotrophic y-naupliar morphospecies in Figs 6–19 emphasize features visible in live specimens, and occasionally exuviae, by light microscopy, such as the general body shape, size, coloration, shape of the labrum, and the form and position of the caudal spines, i.e., characteristics that are generally sufficient for recognizing the morphospecies. The study of more detailed aspects of limb segmentation and setation, body pore pattern, cuticular ridge and facet patterns, etc. has been reserved for later taxonomic work, which will require detailed study of multiple specimens with a variety of microscopic techniques (e.g., Olesen *et al.* 2022; Olesen & Grygier 2022).

Morphological features used to discriminate morphospecies

The general terminology follows earlier works (Itô 1987a,1987b; Kolbasov & Høeg 2003; Grygier *et al.* 2019; Kolbasov *et al.* 2021b; Olesen *et al.* 2022, 2024; Dreyer *et al.* 2023b).

Size. To facilitate the sorting and grouping of specimens, photographs of all 510 LSNs were placed at the same scale on several canvasses in CorelDraw (e.g., Fig. 3). Body width was measured at the widest point in the cephalic region (Fig. 5A, yellow dashed line). Whenever possible, dorsal-ventral body thickness was measured in the region of the boundary between the cephalic shield and the trunk (Fig. 5D, red dashed line). Due to differences between living and preserved specimens and the rotundity and/or moderately to severely bent body shape of many kinds of y-nauplius (see below), standardization

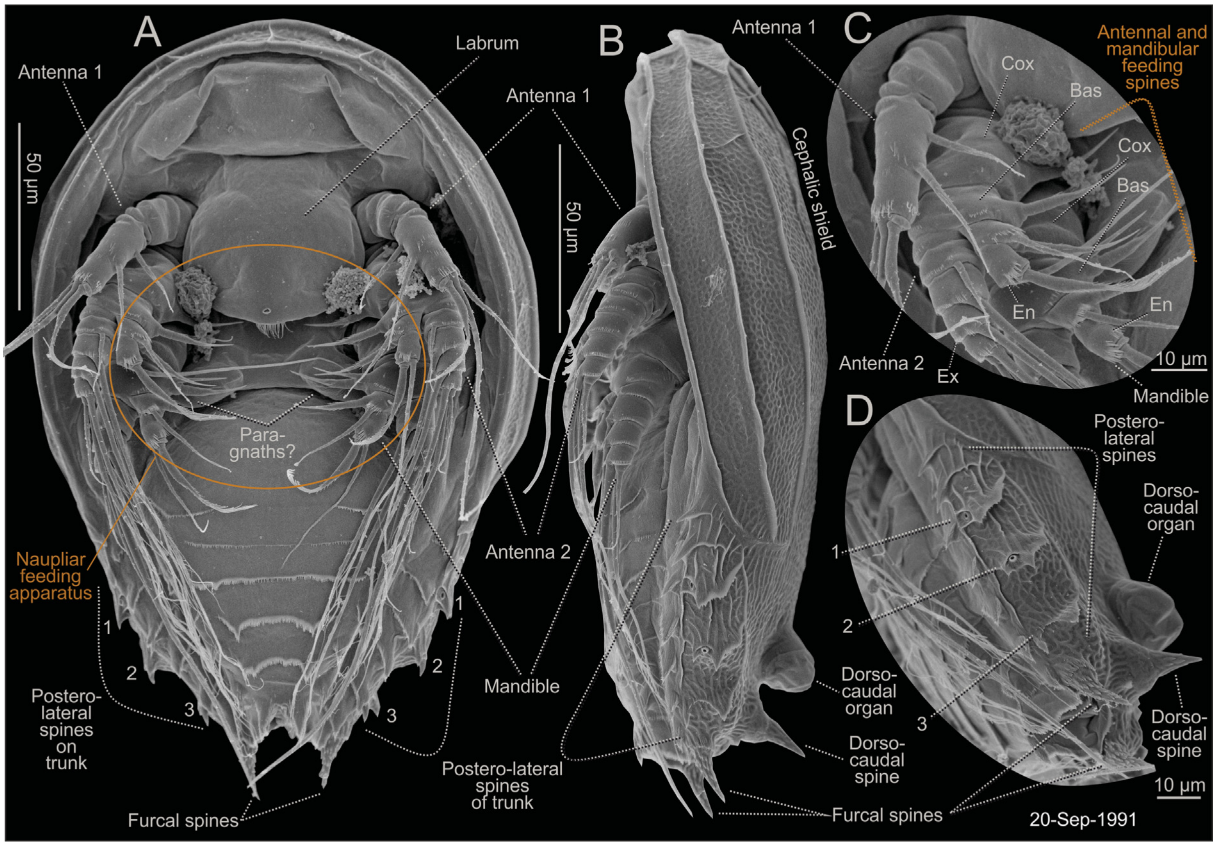

Fig. 4. Planktotrophic (feeding) y-nauplius of morphospecies Type A*. **A**. Ventral view. **B**. Lateral view. **C**. Naupliar feeding apparatus of right side. **D**. Postero-lateral spines of left side, dorso-caudal organ, dorso-caudal spine and furcal spines. The naupliar feeding apparatus, postero-lateral spines, dorso-caudal organ and dorso-ventrally flattened body (especially the first of these) are the key characters for separating planktotrophic y-nauplii from lecithotrophic y-nauplii. Abbreviations: Bas = basis; Cox = coxa; En = endopod; 1–3 = postero-lateral spine rows on trunk.

of length measurements was difficult. Body length was measured from the anterior margin of the cephalic shield to the base of the dorso-caudal spine (spine length not included) (Table S1). The body length of dorso-ventrally flattened (e.g., Type X, Fig. 16A–C) or cylindrical (e.g., *H. demodex*, Fig. 6A–D) naupliar types was easier to obtain than those of bent-body specimens, as the latter tended to be oriented laterally or obliquely on slides, both while alive and as exuviae. Body length of bent-body naupliar types could be measured either by ignoring the bend and simply measuring 'length' as a straight line from anterior to posterior (Fig. 5D, blue dashed line), or by measuring the length in lateral view following the body curvature (Fig. 5D, yellow dashed line). The resulting measurements will be quite different except

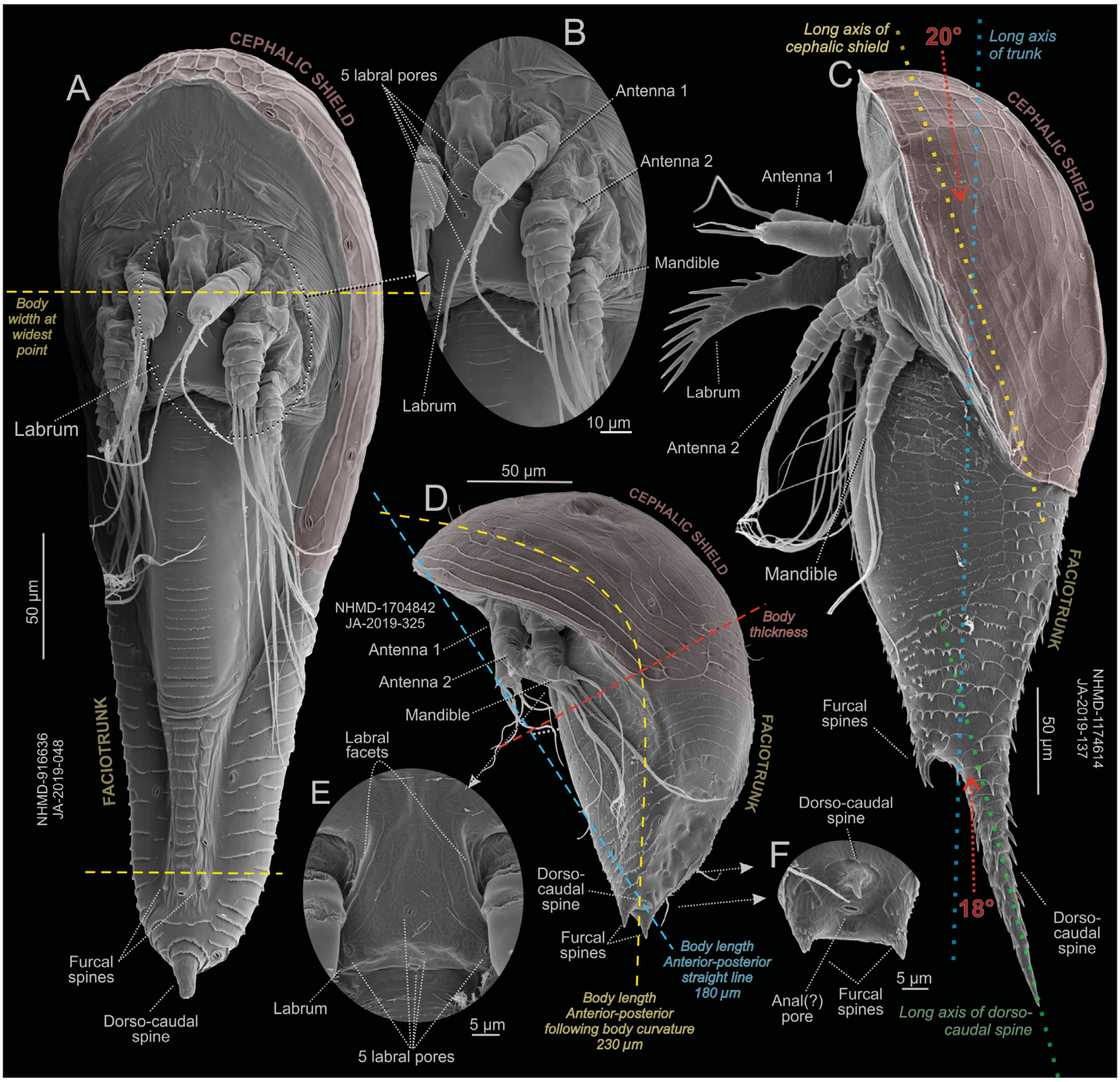

Fig. 5. Scanning electron micrographs of three significantly different kinds of last-stage lecithotrophic (non-feeding) y-nauplii (Facetotecta) illustrating key characters (general body size and shape, and morphology of labrum and caudal spines) used herein to separate and describe 34 y-naupliar morphospecies, with various measurements explained directly on the figure. **A–B**. *Hansenocaris demodex* Olesen *et al.*, 2022, ventral view with detail of labral area. **C**. *Hansenocaris cristalabri* Olesen & Grygier, 2022 (holotype, NHMD), lateral view. **D–F**. Type K, lateral view with details of labrum and caudal spines. A–B from Olesen *et al.* (2022); C from Olesen & Grygier (2022).

in dorso-ventrally flattened or cylindrical specimens. For example, Type K is 180 µm long (Fig. 5D, blue dashed line) when measured as a straight-line distance, but 230 µm long (Fig. 5D, yellow dashed line) when measured following the body curvature. In the description of each naupliar morphospecies, measurements are in most cases based on live specimens, unless specifically stated otherwise (e.g., for SEM or slide-mounted exuviae, the latter probably being somewhat distorted). Body length is indicated as a range based on as many specimens as possible, but measurements for each specimen are specified in Table S1.

Body shape. Body shape was assessed in both ventral and lateral view. Occasionally colloquial terms are used to describe the characteristic shape, form or coloration of some naupliar types, such as ‘spoon-shaped’, ‘racket-shaped’ or ‘bird-talons’ (for types with talon-like furcal spines). Ventral views revealed much variation in the length-width ratio, some naupliar types being about three times as long as wide, such as the semi-vermiform *Hansenocaris demodex* (Figs 5A, 6A–D), while others are almost as wide as long, such as the disc-shaped Type U* (Fig. 12A–B). The body of all y-nauplii tapers from anterior to posterior in ventral view, but at different steepnesses. In *H. demodex* (Figs 5A, 6A–C) the lateral margins only taper weakly, whereas they taper strongly in the disc-shaped Type U* (Fig. 12A–B). Furthermore, some naupliar types taper more or less uniformly, such as *H. demodex* (Fig. 6A–B) and the racket-shaped Type X (Fig. 13A–C), while others exhibit a sharp discontinuity, a distinct notch or an invagination of varying size in the body outline where the cephalic shield and trunk meet, such as in the spoon-shaped *Hansenocaris cristalabri* Olesen & Grygier, 2022 (Fig. 9A–B) and Type E* (Fig. 10A–D) (and many others), in which the cephalic shield is distinctly set off from the posterior body.

Lateral views revealed much variation in how curved or bent y-nauplii are. Some naupliar types are essentially straight-bodied (e.g., *H. demodex* and Types U* and X; Figs 12B, 13A–C), while others are slightly to moderately bent (e.g., Types B, AH* and E*; Figs 7J, 9J, 10D), and some are very strongly bent indeed (e.g., Types G, H and AF; Figs 8E, H, 17A). In the description of each morphospecies, the degree of bending is expressed as the angle between the long axes of the cephalic shield and trunk as defined in Fig. 5C for *H. cristalabri*, i.e., with the cephalic shield’s long axis being measured parallel to the shield’s ventral margins (yellow dotted line), and the trunk’s long axis being measured midway between its dorsal and ventral sides (blue dotted line).

Labrum. Labral structure, as exemplified by, e.g., *H. demodex* and Type K (Fig. 5B, E), differs significantly among different forms of lecithotrophic y-nauplii and, combined with body shape, is by itself sometimes diagnostic of morphospecies. Informative aspects of labral structure include relative size and overall shape; how far and in what form it extends from the cephalon; presence/absence of a medial keel and the keel’s spination, if any; presence/absence of a free posterior margin, the shape thereof, and the presence/absence and size and shape of any median posterior spine; and the pattern of subdivision of the ventral surface into facets by cuticular ridges, if at all. The microscopical techniques employed here did not always permit clear views of the labrum’s facet pattern, nor of its surface pores, but such information is included for some morphospecies when available.

Caudal armature. The three caudal spines, consisting of a median dorso-caudal spine and a pair of furcal spines (for terminology, see Olesen *et al.* 2022), are shown in detail for a few morphospecies (Fig. 5A, C–D, F). Except for the planktotrophic Type A*, none of the y-nauplii treated herein has an obvious dorso-caudal organ on the dorsal side of the trunk, a fact that is not belabored in the descriptions of the 34 lecithotrophic morphospecies.

The dorso-caudal spine varies much in size, shape and subsidiary armament. In some morphospecies (e.g., Types K and AB; Figs 5D, F, 13F–I, 15G–M) it is very small, whereas in others it is broad and blunt (e.g., *H. demodex* and Type C; Figs 5A, 6) or conical (e.g., Types F and AF; Figs 8A–D, 17A–D).

In many nauplii it is very long (e.g., Types AH*, W, X; Figs 9E–J, 11A–G, 13A–E) or even extremely long (*H. cristalabri*, *H. aquila* Olesen & Grygier, 2022; Fig. 9G–L). The form and precise length of the dorso-caudal spine, measured from basis to tip, is mentioned in the description of each naupliar morphospecies. The angle between the dorso-caudal spine and the long axis of the trunk also varies considerably. The spine may extend in the same plane as the rest of the body (e.g., the rather racket-shaped Types X and Y; Figs 13A–C, 16A–C), or it may be deflected dorsally (e.g., Types E* and AF; Figs 10A–D, 17A–D). Whenever possible, the angle of deflection is specified in the description of each morphospecies, but in many cases measurement was difficult due to the dorso-caudal spine's small size (e.g., Types B, C, G, K, AB: Figs 6G–L, 7H–M, 8E–G, 13F–I, 15G–M). In a few cases the dorso-caudal spine was not terminal, and its actual site of origin was a useful sorting criterion. One such example is Type B, with a small, triangular dorso-caudal spine that is situated very far anteriorly on the dorsal side (Fig. 7J, K, M).

Much variation was seen in the morphology of the furcal spines. In most y-nauplii they are rather small and triangular or hooked (e.g., *H. cristalabri* and Types D*, B, AH*; Figs 7A–F, 9B, G–J). In others they are extremely small (e.g., *H. demodex* and Types U* and X; Figs 5A, 12A–D, 13A–E) or even apparently absent (Type AL; Fig. 18A–F). Exceptionally, they may be placed rather far anteriorly on the trunk's ventral surface (*H. demodex*; Figs 5A, 6C, F), take the form of double-spines (Type AI; Fig. 14G–L) or be expressed as large claws oriented at a right angle to the long axis of the trunk (Types G and H: Fig. 8E–J).

Features of cypris y. Because the majority of specimens were videographed alive, morphological aspects of the cyprids developing within the LSNs' exoskeletons could be appraised as supplementary sorting criteria for the nauplii. This includes the shape and size of the y-cyprid's telson, and the coloration of various body parts, whether due to actual pigmentation or the presence of (presumed) yolk granules. The body may be nearly wholly brown (Types D* and L; Figs. 7A–B, 15A–C), or only the telson or its distal part may have brown pigment (e.g., Types C, M, AI, Y, AL, AJ, AK, AM; Figs 6G–H, 14A–I, 16A, 18, 19A–B, H), or else the lateral margins of the cyprid's cephalic shield may be colored brown (Types AJ and AM; Figs 18G–J, 19H) or have large black markings (Type H; Fig. 8H–I). Type AB (Fig. 15G–J) has a spotted and circular pattern of brown/black pigmentation on its telson. In many y-cyprids formed within the LSN, colored or transparent (presumed) yolk granules are present within a central tube, probably the remnants of a gut, which is therefore termed a 'gut-like tube' in the following. The yolk granules are either present along its entire length (e.g., *H. demodex* and Type AF; Figs 6A–B, 17A–C) or only in the cephalic area and/or telson (Types E* and AG*; Fig. 10). In some taxa, massive amounts of presumed yolk granules are present in the cephalic region, sometimes branching into lateral diverticula (Types B, D*, Y, N*, AJ, AM; Figs 7, 16A, 17F–G, 18H, 19H). As examples of distinctively colored yolk granules, those in the gut-like tube are yellow/orange in *H. demodex* (Fig. 6A–B), red pigment occurs between the granules in the gut-like tube in Type H (Fig. 8H–I), brown/black spots of pigment are present in this region in Types AF and AJ (Figs 17A–B, 18H), and Types AG*, X, M, AI, AL and AK have one or a few orange yolk granules in or near the posterior part of the gut-like tube (Figs 10G–H, 13A, 14A–B, 15H–I, 18A–B, 19A–B). Large transparent lipid(?) vesicles are sometimes distributed in a way specific for certain morphospecies along the cyprid's cephalic shield margin, either abundantly along most of the margin (Types W, AD, AB; Figs 11A–C, H–J, 15G–H), a few along the anterior margin (Types E* and AG*; Fig. 10A–B, G–H), or just one medially in front of the nauplius eye (Type AH*; Fig. 9I). The distribution of these internal structures appears most useful for sorting in the early phase of the LSN, since the amount of yolk and number of vesicles in general become reduced during development, as exemplified in *Hansenocaris demodex* (Olesen *et al.* 2022: fig. 11) and Types B, AH*, V, X and AJ (Figs 7H–J, 9I–J, 12E–F, 13A–B, 18G–I), for which specimens at different degrees of development have been examined. Other easily visible variants of y-cyprid internal anatomy include the presence of clusters of smaller vesicles posterior to the compound eyes (Type AH*; Fig. 9I–J) and clusters of crystalline-like particles close to the lateral margins of the cephalic shield (Types G and X; Figs 8E–F, 13A).

An identification key has been constructed for the 34 lecithotrophic morphospecies of last-stage nauplii (LSN) of facetotectans provisionally described herein. See below for its basis and recommendations for use.

Relative abundance of lecithotrophic y-naupliar types in Okinawan shallow water

The relative abundance of the lecithotrophic y-naupliar morphospecies occurring at Sesoko Island could not be measured directly since the majority of newly caught y-nauplii were too early in development to be referred confidently to particular (morpho)species. Relative abundance could, however, be estimated indirectly for the material obtained in 2018 and 2019 based on last-stage nauplii that were reared in the laboratory. Owing to great uncertainty concerning taxonomic boundaries, planktotrophic y-nauplii were not included in this survey of relative abundance. A correlation coefficient between abundance and naupliar size (expressed as length) was calculated using the CORREL function in Microsoft Excel.

Results

Taxonomy

Class Thecostraca Gruvel, 1905
Subclass Facetotecta Grygier, 1985
Family Hansenocarididae Olesen & Grygier, 2022

Genus ***Hansenocaris*** Itô, 1985

Descriptions of y-naupliar morphospecies (‘types’) from Okinawan shallow water

Brief descriptions are presented below for one morphospecies (Type A*) of planktotrophic y-nauplius and 34 lecithotrophic morphospecies with alphabetical designations that match those used by Dreyer *et al.* (2023a) for the same putative taxa, with some additions. The planktotroph is included to facilitate the separation of planktotrophic and lecithotrophic y-nauplii from each other as the first step in using the identification key that follows the descriptions. To facilitate comparisons, the descriptions normally present similar types of information in the following order for last-stage nauplii (LSN): 1) general features; 2) length:width ratio; 3) shape in ventral view; 4) shape in lateral view; 5) measurements of length, width and thickness; 6) features of the labrum; and 7) features of the caudal end. The following features of the developing cyprids within the LSN cuticle are also mentioned: 1) coloration; 2) condition of yolk granules (if any); 3) distribution of marginal lipid vesicles (if any); and 4) features of the telson. The descriptions are accompanied by detailed figures (Figs 6–19) to facilitate identification using the key. The lecithotrophs include three formally described species—*Hansenocaris demodex*, *H. cristalabri* and *H. aquila* (Olesen *et al.* 2022; Olesen & Grygier 2022)—and 31 undescribed morphospecies, a few of which were given ‘nicknames’ in earlier literature and some of which probably represent more than one species according to recent molecular systematic data (Dreyer *et al.* 2023a). Further treatment of the other kinds of planktotrophic y-nauplii shown in Fig. 2C is postponed. Examples of live video of most of the y-naupliar morphospecies can be seen at https://youtu.be/er0mYLswV-c and are also deposited at Figshare.com: https://doi.org/10.6084/m9.figshare.24953568.v1.

Y-nauplius **Type A***
Figs 1C, 2C, 4

Pacific Type I – Itô 1986a (partim): 86, fig. 1h–i. — Watanabe *et al.* 2000: 6, 10–11, fig. 21, corrected fig. 6. — Olesen *et al.* 2022: 556, 578–579, 585, 587–588, figs 2, 14d, 15, table 6. — Dreyer *et al.* 2023b: 85, 99, 112–113, figs 2, 5.

Type A* – Dreyer *et al.* 2023a: figs 2, 5a, c, tables s1–s2. — Dreyer *et al.* 2024: 8, fig. 1.

Material examined

JAPAN – **Okinawa, Sesoko I., laboratory pier; 26°38′09.4″ N, 127°51′55.2″ E** • 1 spec.; 20 Sep. 1991 • 1 spec.; 18 Oct. 2018; JA-2018-055, voucher unavailable. Sixty or more specimens belonging to this type were photographed during fieldwork in 2018/19, 12 of which were sequenced for molecular work in Dreyer *et al.* (2023a).

Description

Nauplius of unknown stage. Planktotrophic. Body approximately droplet-shaped in ventral view, about 1.4 times as long as wide; lateral margins tapering gradually towards caudal end with no discontinuity at posterior end of cephalic shield. Body nearly straight in lateral view, with trunk axis downturned ca 15° relative to cephalic axis. Length 190 µm (based on SEM), greatest width 135 µm, greatest dorso-ventral thickness 60 µm. Labrum sub-quadrangular, not divided into facets by cuticular ridges, bearing (at least) one pore in midline and two more pores in postero-lateral corners (both covered with dirt or secretions in illustrated specimen); posterior margin with median cluster of setae. First antenna divided into two distinct segments, distal of which carries two postaxial and three apical setae. Second antenna and mandible both with median feeding apparatus, including one spine on coxa and basis of each. Second antennal endopod two-segmented with setal formula 1 : 2, 2 : 2; exopod six-segmented with setal formula 1 : 0, 2 : 1, 3 : 1, 4 : 1, 5 : 1, 6 : 2. Mandibular endopod two-segmented with setal formula 1 : 2, 2 : 2; exopod five-segmented with setal formula 1 : 0, 2 : 1, 3 : 1, 4 : 1, 5 : 2. Transverse fold ventrally behind labrum carrying pair of putative paragnaths. Ventral side of trunk with about five transverse rows of cuticular ridges. Postero-lateral margins lined with complicated arrangement (basically two rows) of laterally projecting spines; these forming scale-like structures, with three of these being particularly prominent (numbered 1–3 in Fig. 4A, D): #2 projecting farthest; scales #1 and #2 each with embedded pore. Trunk terminating in pair of slender furcal spines, with robust dorso-caudal spine projecting dorsally, preceded by semi-globular dorso-caudal organ. Cephalic shield incompletely divided into facets and bearing setae and pores, but these details not shown or described here.

Identification and variation

Recognizable among other planktotrophic nauplii by the combination of its small size, the projecting postero-lateral scale #2, the dorso-caudal organ on the trunk's dorsal side, the dorsally projecting dorso-caudal spine and (in live specimens) the red-orange-colored gut-like central tube.

Distribution

Japan (Sesoko Island, Okinawa; Tanabe Bay, Wakayama), Taiwan (Green Island), Azores.

Remarks

Twelve specimens, sorted as Type A*, were sequenced by Dreyer *et al.* (2023a). They grouped together in the resulting phylogenetic tree, but with a large molecular variation among them, suggesting that Type A* is composed of multiple species. Those of our specimens that have been examined with SEM (Fig. 4; Dreyer *et al.* 2023b: fig. 2) resemble one of Itô's Pacific Type I specimens (Itô 1986a: fig. 1h, j) but differ from Itô's other specimen (Itô 1986a: fig. 1a–g), supporting Grygier's conclusion (Grygier 1991) that the specimens treated by Itô (1986a) as 'Pacific Type I' did not merely represent different instars but were not conspecific.

Hansenocaris demodex Olesen, Dreyer, Palero & Grygier in Olesen *et al.*, 2022

Figs 2, 5A–B, 6A–F

Hansenocaris demodex Olesen, Dreyer, Palero & Grygier in Olesen *et al.*, 2022: 570, figs 3–15, table 6.

Hansenocaris demodex – Dreyer *et al.* 2023a: figs. 2, 5a, c, tables 3–6, s1–s2; 2023b: 85, 90, 94, 95, 97–100, 115, 118; 2024: 8, fig. 1. — Olesen *et al.* 2024: fig. 1.

Material examined

JAPAN – **Okinawa, Sesoko I., laboratory pier, 26°38′09.4″ N, 127°51′55.2″ E** • 1 LSN; 1991–2005 • 9 LSN, 4 of which molted to cyprids; 2018–2019 (Tables 1 and S1).

Description

Last-stage nauplius (LSN). Lecithotrophic. Body narrowly ovate, almost lanceolate in dorso-ventral view; subcylindrical and semi-vermiform; about 2.6 times as long as wide; lateral margins tapering gradually towards caudal end with no discontinuity at posterior end of cephalic shield. In lateral view,

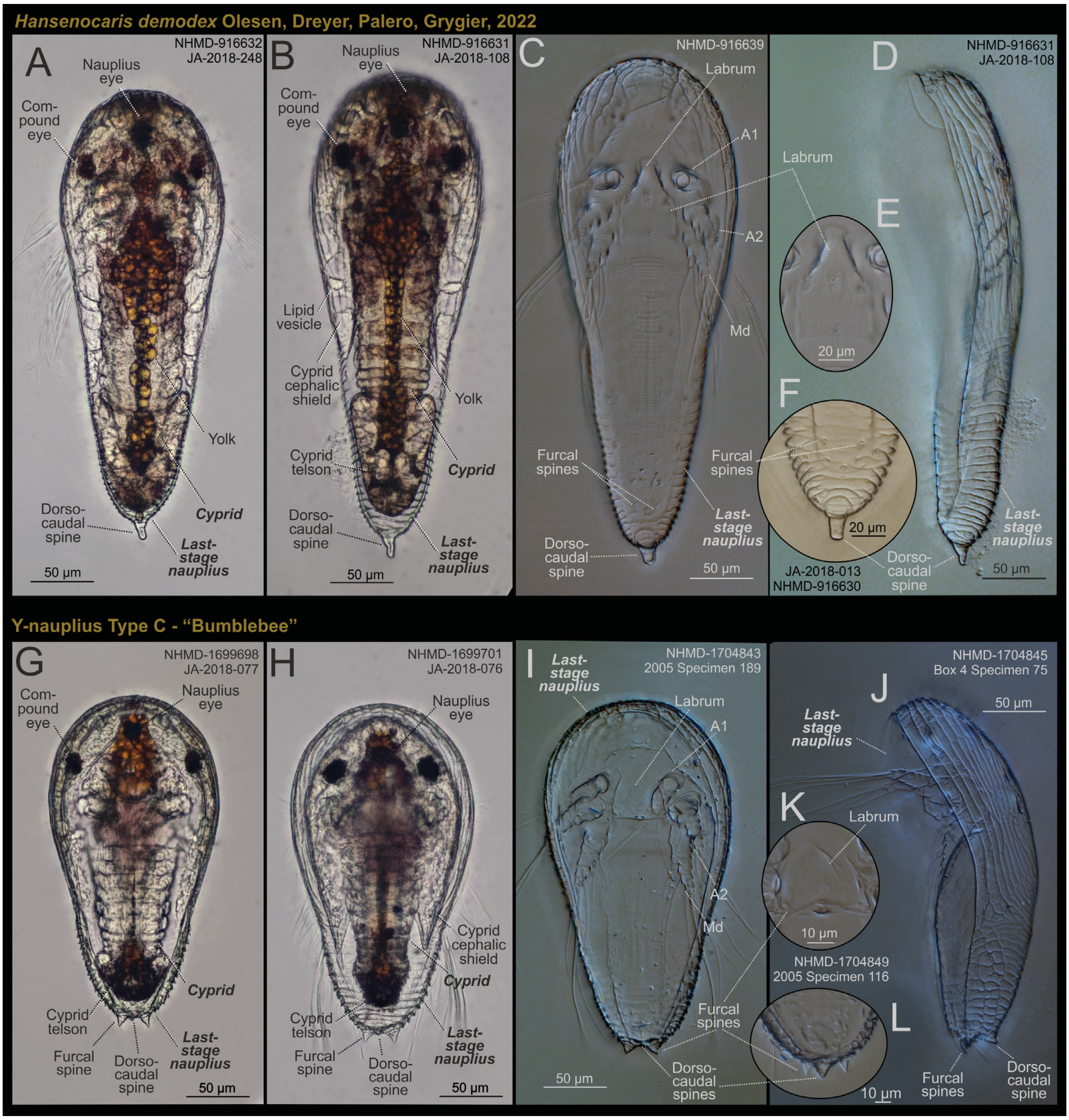

Fig. 6. Last-stage nauplii of two different (morpho)species of y-larvae (Facetotecta) from Sesoko Island (Okinawa, Japan). **A–F**. *Hansenocaris demodex* Olesen *et al.*, 2022 (all paratypes). **G–L**. Type C (‘Bumblebee’). Shown either in life (A–B, G–H) or as slide-mounted exuviae (C–F, I –L). Abbreviations: A1 = first antenna; A2 = second antenna; Md = mandible.

trunk axis downturned 30° relative to cephalic axis. Length 352–390 µm (without dorso-caudal spine), greatest width 140 µm, greatest dorso-ventral thickness 100 µm. Labrum a triangular elevation twice as long as wide, not divided into facets by cuticular ridges, bearing five pores: two in mid-line centrally, one in mid-line at posterior margin and pair at left and right lateral margins. Caudal end rounded, terminating in short, blunt, mucronate dorso-caudal spine preceded at some distance on ventral surface by pair of tiny furcal spines.

Cypriid viewed through cuticle of LSN. Cyprid body overall brownish-pigmented, most notably in anterior part of cephalic shield, anterior thoracic segments and posterior tip of telson. Orange and brownish yolk granules concentrated in longitudinally-oriented central gut-like tube, this being broadened somewhat in telson, much more so in anterior part of thorax. Pair of lipid vesicles present laterally in cephalic shield. Telson large, about as long as thorax, narrowly cordate in dorso-ventral view with anterior end wider than thorax and with rounded posterior margin.

Identification and variation

Easily recognizable based on the combination of its elongate, semi-vermiform shape, brown or yellow color, elongate labral region, short, blunt dorso-caudal spine, small furcal spines and (within the LSN) the cyprid's very long, posteriorly rounded telson. Olesen *et al.* (2022) described morphological variation among LSN specimens in the size and bluntness of the dorso-caudal spine, the symmetry of the cephalic shield's facet array and the pigmentation of the cyprid developing within the LSN (Sesoko Island: brownish; Green Island: yellowish; such also being the coloration of earlier naupliar stages). The minor molecular variation between all sequenced specimens tends to confirm their conspecificity (Olesen *et al.* 2022; Dreyer *et al.* 2023a).

Distribution

Japan (Sesoko Island, Okinawa), Taiwan (Green Island and Xiaoliuqiu Island).

Y-nauplius **Type C**

Figs 2, 6G–L

"Bumblebee" – Olesen *et al.* 2022: 578, 585, 587, figs 14b, 15, table 6. — Dreyer *et al.* 2023b: 99, figs 3a–e, 7.
Type C – Dreyer *et al.* 2023a: figs 1c, 2, 5a, c, s1–s2, tables s1–s2; 2024: 8, fig. 1.
Undescribed species of "y-larvae" – Olesen 2024: fig. on p. 15.

Material examined

JAPAN – **Okinawa, Sesoko I., laboratory pier, 26°38′09.4″ N, 127°51′55.2″ E** • 8 LSN; 1991–2005 • 40 LSN, 27 of which molted to cyprids; 2018–2019 (Tables 1 and S1).

Description

Last-stage nauplius (LSN). Lecithotrophic. Body narrowly ovate in dorso-ventral view; about twice as long as wide; lateral margins tapering gradually towards caudal end with no discontinuity at posterior end of cephalic shield. In lateral view, trunk axis downturned 30–45° relative to cephalic axis. Length 250–275 µm (without dorso-caudal spine), greatest width 150 µm, greatest dorso-ventral thickness 70 µm. Labrum weakly elevated, broadly trapezoidal with rounded posterior corners and approximately as long as wide; not divided into facets by cuticular ridges; bearing five pores: row of three posteriorly in midline and pair in left and right postero-lateral corners. Caudal end rounded, terminating in short (ca 7–10 µm), conical dorso-caudal spine and pair of short (10 µm), broad, upwardly curved furcal spines.

Cypriid viewed through cuticle of LSN. Thorax brown, telson brown/black. Orange yolk granules concentrated centrally in cephalon posterior to nauplius eye and in posterior part of gut-like central tube.

Telson approximately as long as wide and less than half as long as thorax, with notably bulging anterior half.

Identification and variation

Easily recognizable by the combination of its obtuse-ovate shape, distinctive black-brown-orange coloration (on which the nickname is based) and the three short, broad caudal spines. There is very little variation among specimens except for changes in pigment distribution as cyprid development progresses within the LSN cuticle, and only insignificant molecular variation was found among seven sequenced specimens (Olesen *et al.* 2022; Dreyer *et al.* 2023a, 2024).

Distribution

Japan (Sesoko Island, Okinawa).

Y-nauplius **Type D***

Figs 2, 7A–G

"Big brown" – Grygier *et al.* 2019: fig. 4. — Olesen *et al.* 2022: 578, 585, 587– 88, figs 2, 14c, 15, table 6.

Type D* – Dreyer *et al.* 2023a: figs 2, 5a, c, tables s1–s2; 2024: 8, fig. 1.

Material examined

JAPAN – **Okinawa, Sesoko I., laboratory pier, 26°38′09.4″ N, 127°51′55.2″ E** • 4 LSN; 1991–2005 • 35 LSN, 23 of which molted to cyprids; 2018–2019 (Tables 1 and S1).

Description

Last-stage nauplius (LSN). Lecithotrophic. Body narrowly ovate in dorso-ventral view; about twice as long as wide; lateral margins tapering gradually towards caudal end with no discontinuity at posterior end of cephalic shield. In lateral view, trunk axis downturned ca 30–45° relative to cephalic axis. Length 310–360 µm (without dorso-caudal spine), greatest width 170 µm, greatest dorso-ventral thickness 60–70 µm. Labrum weakly elevated, approximately as long as wide and sub-pentagonal in outline; surface not obviously divided into facets by cuticular ridges; bearing five pores: row of three in midline posteriorly and pair situated at lateral margins on right and left sides. Body terminating in long (ca 50 µm, width at base ca 12 µm), straight, smooth or weakly terraced dorso-caudal spine with long axis either in same plane as trunk axis or upturned ca 20° relative to latter and pair of shorter but still prominent (15–20 µm), fairly sharp, dorsally or dorso-medially curved furcal spines.

Cyprid viewed through cuticle of LSN. Body overall markedly brownish-pigmented. Orange yolk granules seen most clearly in cephalon and telson, sometimes also concentrated centrally in body but often more widely distributed. Telson of variable outline in ventral view, as long as wide or longer, approximately half as long as thorax.

Identification and variation

Easily recognizable by the combination of its brown coloration and somewhat extended overall body shape, the lengths of the three caudal spines and (at least in some) the obvious medial component of the furcal spines' curvature. Morphological variation among specimens in body size, the angle between the dorso-caudal spine and the hind-body, and the size and degree of curvature of the furcal spines suggests that more than one species may be involved. The molecular diversity of 13 specimens sequenced by Dreyer *et al.* (2023a) also suggests that this morphospecies consists of two or three separate species.

Distribution

Japan (Sesoko Island, Okinawa), Taiwan (Wanghaixiang Fishing Harbour, Keelung).

Y-nauplius **Type B**
Figs 2, 7H–M

Type B – Dreyer *et al.* 2023a: figs 2, 5a, c, tables s1–s2.

Material examined

JAPAN – **Okinawa, Sesoko I., laboratory pier, 26°38′09.4″ N, 127°51′55.2″ E** • 1 LSN; 1991–2005 • 3 LSN, 1 of which molted to cyprid; 2018–2019 (Tables 1 and S1).

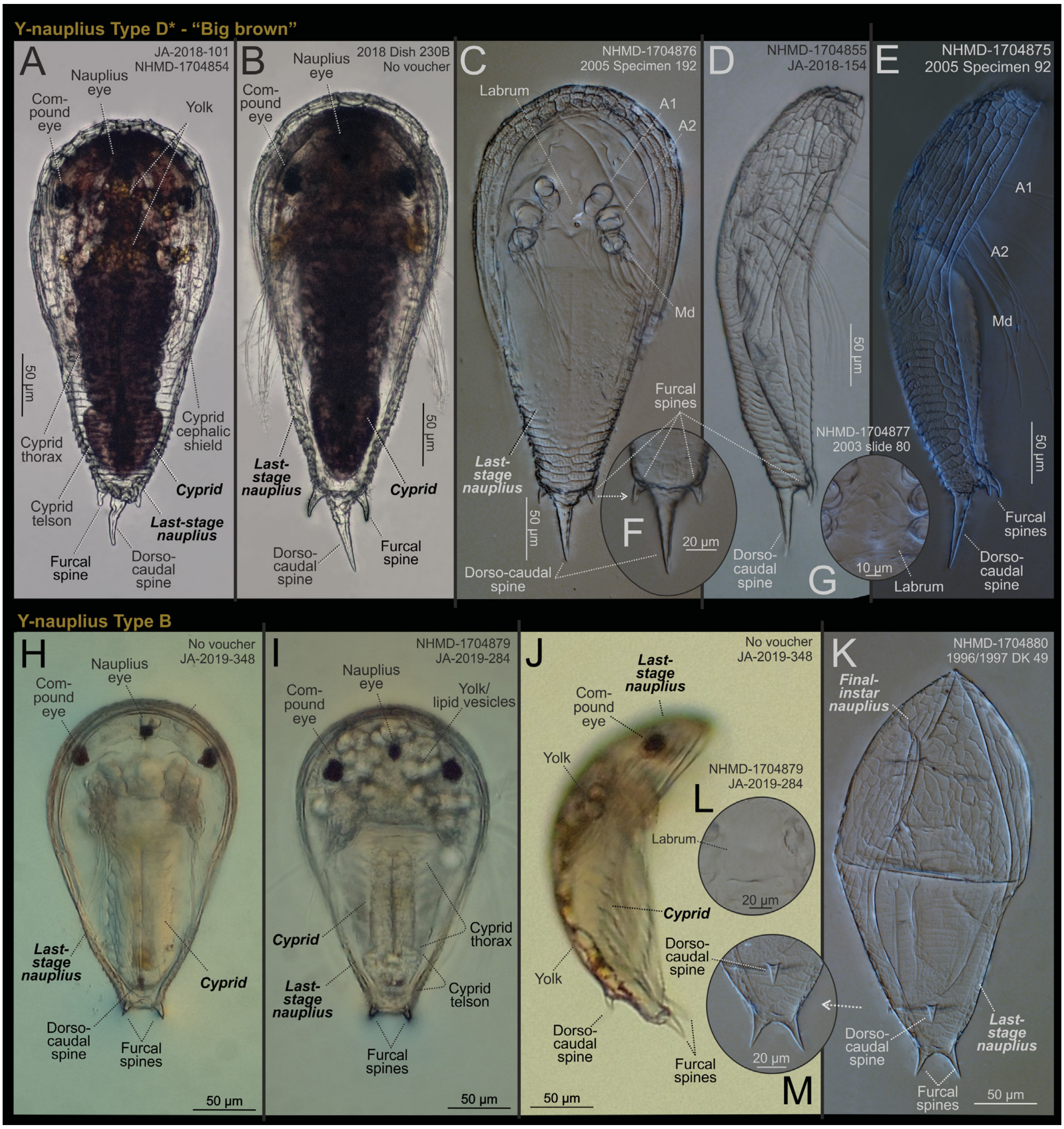

Fig. 7. Last-stage nauplii of two different morphospecies of y-larvae (Facetotecta) from Sesoko Island (Okinawa, Japan). **A–G**. Type D* ("Big brown"). **H–M**. Type B. Shown either in life (A–B, H–J) or as slide-mounted exuviae (C–G, K–M). Abbreviations: A1 = first antenna; A2 = second antenna; Md = mandible.

Description

Last-stage nauplius (LSN). Lecithotrophic. Body ovate in dorso-ventral view; about twice as long as wide; lateral margins tapering gradually towards caudal end with no discontinuity at posterior end of cephalic shield. Dorsum evenly curved in lateral view, with trunk axis downturned 50–55° relative to cephalic axis. Length 250–265 µm (without dorso-caudal spine), 275 µm in lateral view following body curvature; greatest width 160 µm and greatest dorso-ventral thickness 70–75 µm. Labrum weakly elevated, sub-quadrangular, approximately as long as wide; surface not divided into facets by cuticular ridges; pore pattern not examined in detail. Caudal end narrowly truncate, terminating in short (12 µm), triangular dorso-caudal spine positioned unusually far anteriorly on dorsal side and pair of longer (20 µm), narrow, sharply pointed, slightly upcurved and diverging furcal spines.

Cyprid viewed through cuticle of LSN. Body practically unpigmented, although naupliar appendages weakly brownish. Gut-like tube packed with orange-brown yolk granules. Telson small, wider than long, significantly shorter than half of thorax length.

Identification and variation

Easily recognizable by its unusually forward-positioned dorso-caudal spine, evenly curved (in lateral view) body and broadly triangular ventral trunk region. No distinct variation was apparent among the few examined specimens.

Distribution

Japan (Sesoko Island, Okinawa).

Y-nauplius **Type F**

Figs 2, 8A–D

Type F – Dreyer *et al.* 2023a: figs 3, 5a, c, tables s1–s2.

Material examined

JAPAN – **Okinawa, Sesoko I., laboratory pier, 26°38′09.4″ N, 127°51′55.2″ E** • 2 LSN; 1991–2005 • 5 LSN, 1 of which molted to cyprid; 2018–2019 (Tables 1 and S1).

Description

Last-stage nauplius (LSN). Lecithotrophic. Body ovate in dorso-ventral view; about 1.4 times as long as wide; lateral margins tapering gradually towards caudal end with no discontinuity at posterior end of cephalic shield. Dorsum evenly but strongly curved in lateral view, with trunk axis downturned 65° relative to cephalic axis. Length ca 300 µm (anteroventral view, without dorso-caudal spine), 310 µm in lateral view following curvature of body, greatest width 220 µm, greatest dorso-ventral thickness ca 70 µm. Labrum elevated, pentagonal, about as long as wide, with distinct and free posterior margin; other details unknown. Body narrowly rounded, terminating in short, conical dorso-caudal spine and pair of longer (25 µm), curved, robust furcal spines situated ventrally slightly forward from caudal end.

Cyprid viewed through cuticle of LSN. Body overall weakly brownish, but pigment most heavily concentrated in telson and in naupliar appendages. Central-dorsal gut-like tube devoid of distinct yolk granules except for some orange granules in trunk. Telson much shorter than wide, distinctly less than half as long as thorax. About six lipid vesicles present along anterior margin of cephalon and four along posterior margin of labrum.

Identification and variation

Easily recognizable by the combination of its distinctly downturned trunk region, short, conical dorso-caudal spine and robust but still unremarkably long, curved furcal spines positioned forward from the caudal end. The last feature makes this a ‘short-talon’ morphospecies in comparison to the next two described below.

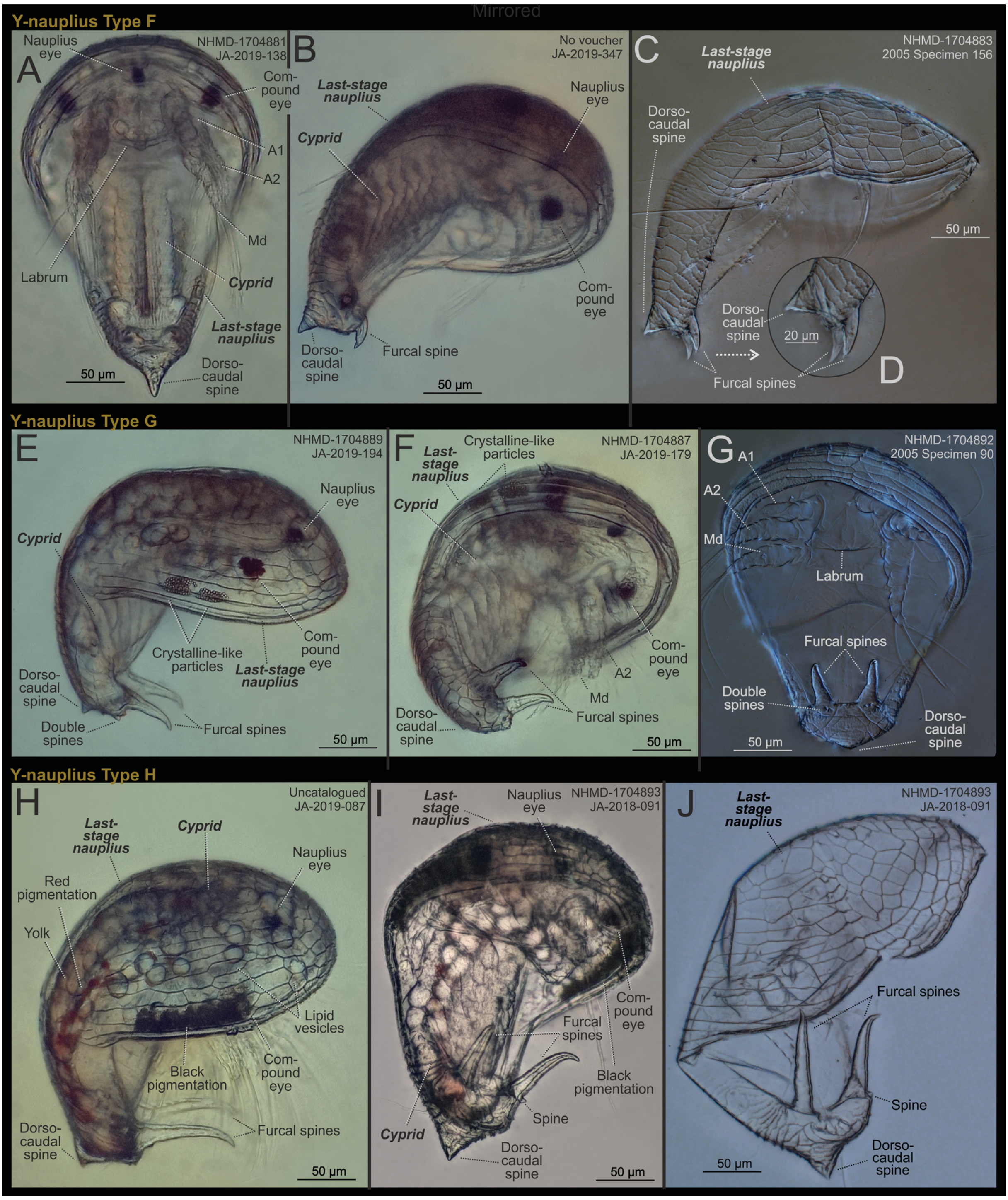

Fig. 8. Last-stage nauplii of three different morphospecies of y-larvae (Facetotecta) from Sesoko Island (Okinawa, Japan). **A–D**. Type F. **E–G**. Type G. **H–J**. Type H. Shown either in life (A–B, E–F, H–I) or as slide-mounted exuviae (C–D, G, J). Abbreviations: A1 = first antenna; A2 = second antenna; Md = mandible.

Distribution

Japan (Sesoko Island, Okinawa).

Y-nauplius **Type G**

Figs 2, 8E–G

Type G – Dreyer *et al.* 2023a: figs 3, 5a, c, tables s1–s2.

Material examined

JAPAN – **Okinawa, Sesoko I., laboratory pier, 26°38′09.4″ N, 127°51′55.2″ E** • 3 LSN; 1991–2005 • 21 LSN, 6 of which molted to cyprids; 2018–2019 (Tables 1 and S1).

Description

Last-stage nauplius (LSN). Lecithotrophic. Body widely ovate in dorso-ventral view; about 1.2 times as long as wide; lateral margins tapering gradually towards caudal end with no marked discontinuity at posterior end of cephalic shield. In lateral view trunk axis downturned a full 90° relative to cephalic axis, with furcal spines directed anteriorly from end of trunk (i.e., anatomically ventrally but parallel to cephalic axis). Body length ca 300–320 µm (following body curvature in lateral view) (without dorso-caudal spine), greatest width 220 µm, greatest dorso-ventral thickness ca 100 µm. Labrum elevated, trapezoidal, about as long as wide with distinct posterior margin and with surface divided into facets by cuticular ridges; pore pattern not examined. Caudal end rounded, terminating in very short (8 µm), conical dorso-caudal spine and pair of long (40 µm), distally curved, talon-like furcal spines with pair of double-spines at (anatomically) dorsal base of each.

Cyprid viewed through cuticle of LSN. Body weakly brown-pigmented. Many lipid vesicles present in dorsal part of cephalon, and, in some specimens, a dense concentration of yolk granules in central gut-like tube. Lateral margins of cephalic region with clusters of crystalline-like particles.

Identification and variation

Easily recognizable by the combination of its right-angle bend of the body, the large, talon-like furcal spines (‘medium talon’ in comparison to the most similar morphospecies, Types F and H), accompanied by small, basal double-spines, and the lateral clumps of crystalline particles within the margins of the cephalic shield (possibly remnant from the LSN).

Distribution

Japan (Sesoko Island, Okinawa).

Y-nauplius **Type H**

Figs 2, 8H–J

Type H – Dreyer *et al.* 2023a: figs 3, 5a, c, tables s1–s2. — Olesen *et al.* 2024: fig. 3a.

Material examined

JAPAN – **Okinawa, Sesoko I., laboratory pier, 26°38′09.4″ N, 127°51′55.2″ E** • 5 LSN, 2 of which molted to cyprids; 2018–2019 (Tables 1 and S1).

Description

Last-stage nauplius (LSN). Lecithotrophic. Body widely ovate in postero-dorsal view; about 1.2 times as long as wide; lateral margins tapering gradually towards caudal end with some discontinuity at posterior end of cephalic shield. In lateral view, trunk axis downturned a full 90° relative to cephalic axis. Length ca 350 µm (in lateral view following body bend, without dorso-caudal spine), greatest width 210 µm, greatest dorso-ventral thickness ca 100 µm. Labrum not examined. Body terminating in very short (8 µm), conical dorso-caudal spine and very long (85 µm), curved, ventrally directed (thus parallel to cephalic axis) furcal spines with small spine at base of each.

Cyprid viewed through cuticle of LSN. Body weakly brown-pigmented. Many lipid vesicles present in dorsal part of cephalon, and dense concentration of yolk granules along entire length of central gut-like tube. Red pigmentation associated with yolk granules in gut-like tube. Lateral margins of cephalon with large, rectangular areas of black pigmentation. Telson short, less than half as long as thorax, with black pigmentation (possibly remnant from the LSN).

Identification and variation

Easily recognizable by the combination of its right-angle bend of the body, the very large, talon-like furcal spines ('large talon' in comparison to the most similar morphospecies, Types F and G), accompanied by small basal spines, red pigmentation associated with the yolk granules in the gut-like tube and the large areas of black pigmentation laterally on the margins of the cephalic shield.

Distribution

Japan (Sesoko Island, Okinawa), Taiwan (Green Island).

Hansenocaris cristalabri Olesen & Grygier, 2022

Figs 2, 5C, 9A–B

Hansenocaris cristalabri Olesen & Grygier, 2022: 304, figs 1–5, tables 1–2.

Hansenocaris cristalabri – Dreyer *et al.* 2023b: fig. 1d.
One of "three known larval types of 'y-larvae'" – Olesen 2024: fig. in upper right corner on p. 17.

Material examined

JAPAN – **Okinawa, Sesoko I., laboratory pier, 26°38′09.4″ N, 127°51′55.2″ E** • 1 LSN; 2018–2019 (Tables 1 and S1).

Description

Last-stage nauplius (LSN). Lecithotrophic. Body spoon-shaped in dorso-ventral view; about twice as long as wide (without dorso-caudal spine); cephalic shield broadly rounded, with sharp discontinuity in body outline leading into trunk. In lateral view, body only slightly bent, trunk axis downturned 15–20° relative to cephalic axis. Length ca 330 µm (ventral view in life, without dorso-caudal spine), greatest width 180 µm, greatest dorso-ventral thickness ca 100 µm. Labrum with goblet-shaped outline in ventral view and posterior margin free; labral surface divided into facets by cuticular ridges; midline of labrum extending ventrally as huge, cockscomb-like, spine-bearing crest. Cephalic shield with spines bordering pair of pits at postero-lateral corners. Trunk dorsum with two longitudinal rows of spines. Caudal end attenuate, terminating in 120 µm long, robust, and conical dorso-caudal spine armed with smaller spines and accompanied ventrally at base by pair of curved, 15 µm long furcal spines; dorso-caudal spine upturned 20° relative to trunk axis.

Cyprid viewed through cuticle of LSN. Body weakly brownish with darker brown pigmentation in parts of thorax and telson. Telson less than half as long as thorax.

Identification and variation

Easily recognizable by its huge and unique labral crest-like process, the spines near the postero-lateral corners of the cephalic shield, the two longitudinal rows of spines dorsally on the trunk and the very long, robust and distinctly spinose dorso-caudal spine.

Distribution

Japan (Sesoko Island, Okinawa).

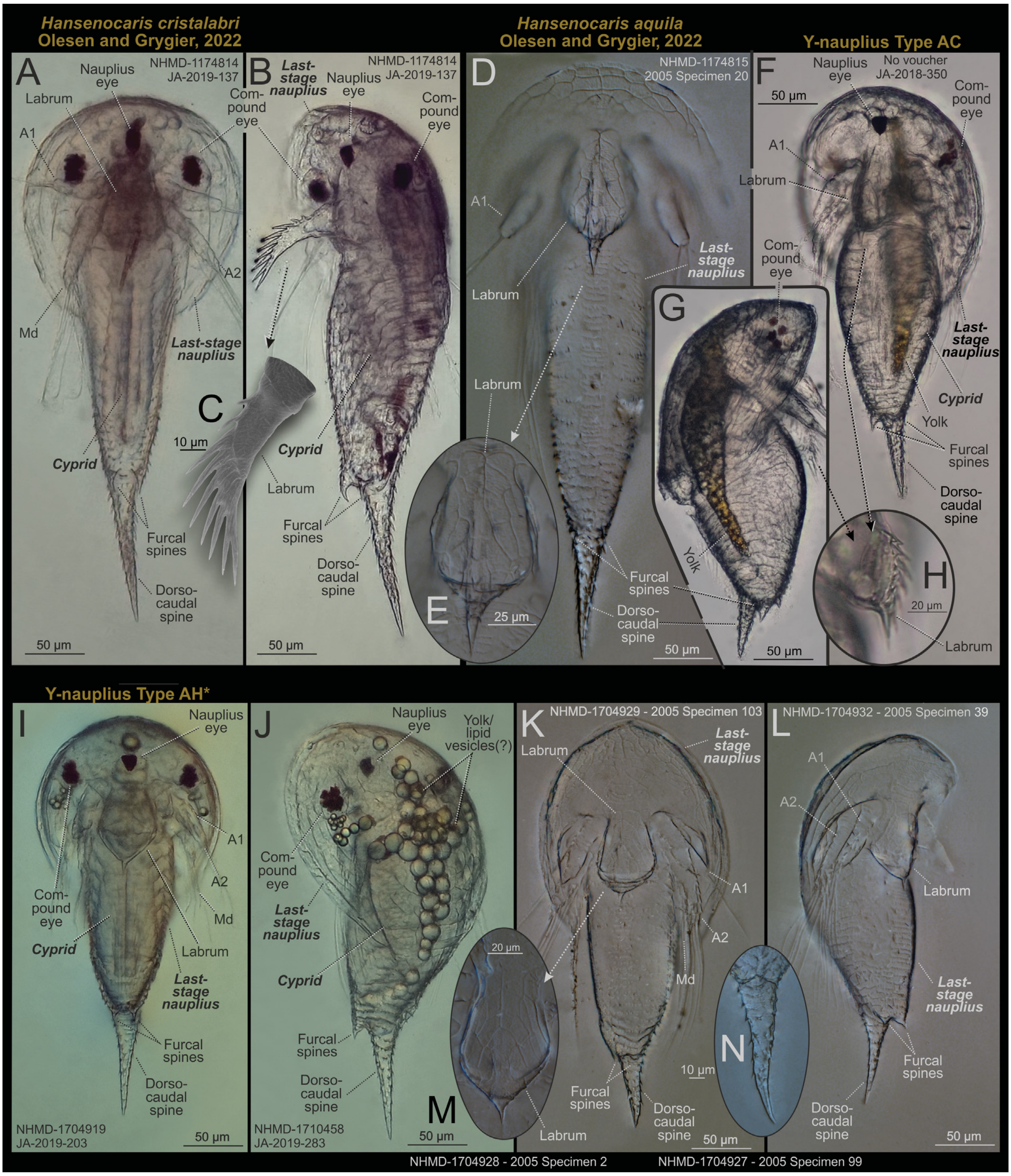

Fig. 9. Last-stage nauplii of four different morphospecies of y-larvae (Facetotecta) from Sesoko Island (Okinawa, Japan). **A–C**. *Hansenocaris cristalabri* Olesen & Grygier, 2022. **D–E**. *Hansenocaris aquila* Olesen & Grygier, 2022. **F–H**. Y-nauplius Type AC. **I–N**. Y-nauplius Type AH*. Shown either in life (A–B, F–H, I–J), as slide-mounted exuviae (D–E, K–N) or in SEM (C). Abbreviations: A1 = first antenna; A2 = second antenna; Md = mandible. A–E from Olesen & Grygier (2022).

Hansenocaris aquila Olesen & Grygier, 2022
Figs 2, 9D–E

Hansenocaris aquila Grygier &Olesen, 2022: 307, fig. 6.

Hansenocaris aquila – Olesen *et al.* 2024: fig. 2.

Material examined

JAPAN – **Okinawa, Sesoko I., laboratory pier, 26°38′09.4″ N, 127°51′55.2″ E** • 2 LSN; 1991–2005 (Tables 1 and S1).

Description

Last-stage nauplius (LSN). Lecithotrophic. Body spoon-shaped in dorso-ventral view; about twice as long as wide; cephalic shield broadly rounded, with sharp discontinuity in body outline leading into trunk. In lateral view, trunk axis bent downwards ca 40° with respect to cephalic axis. Length 400 µm (ventral view of mounted exuvia, without dorso-caudal spine), greatest width ca 210 µm, dorso-ventral thickness ca 120 µm. Labrum with goblet-shaped outline in ventral view, its free posterior margin extending into large medial spine (‘stem’ of ‘goblet’), preceded by four small spines on labral midline; labral surface divided into facets by cuticular ridges. Trunk dorsum with four longitudinal rows of spines. Caudal end attenuate, terminating in 100 µm long, robust dorso-caudal spine armed with many smaller spines and accompanied ventrally at base by pair of small, ca 5 µm long furcal spines; long axis of dorso-caudal spine upturned 15° with respect to trunk axis.

Cyprid viewed through cuticle of LSN. No live specimens examined.

Identification and variation

Easily recognizable by its labrum with the posterior margin extended into a large, eagle-beak-like median spine preceded by ca four small spines on the midline; also distinguished by the four dorsal rows of longitudinal spines on the trunk and the very long, robust and distinctly spinose dorso-caudal spine.

Distribution

Japan (Sesoko Island, Okinawa).

Y-nauplius **Type AC**
Figs 2, 9F–H

Type AC – Dreyer *et al.* 2023a: figs 4, 5a, c, tables s1–s2.

Material examined

JAPAN – **Okinawa, Sesoko I., laboratory pier, 26°38′09.4″ N, 127°51′55.2″ E** • 1 LSN; 2018–2019 (Tables 1 and S1).

Description

Last-stage nauplius (LSN). Lecithotrophic. Body spoon-shaped in dorso-ventral view; 1.8 times as long as wide; cephalic shield elliptical, with sharp discontinuity in body outline leading into trunk. In lateral view, trunk axis downturned ca 35° with respect to cephalic axis. Length ca 270 µm (ventral view in life, without dorso-caudal spine), greatest width 160 µm, greatest dorso-ventral thickness ca 115 µm. Labrum with goblet-shaped outline; in ventral view with free posterior margin extended into large medial spine, preceded by ca six large, equal-sized posteriorly directed spines on labral midline; pore pattern not examined. Caudal end attenuate, terminating in robust, 67 µm-long dorso-caudal spine set with smaller spines and accompanied ventrally at base by pair of triangular furcal spines ca 12 µm long; long axis of dorso-caudal spine upturned 25° with respect to trunk axis.

Cypriid viewed through cuticle of LSN. Body weakly brownish, with thick strand of orange yolk granules in gut-like central tube. Other details not discernable in the single specimen examined.

Identification and variation

Recognizable by the combination of its general shape, size and spiny-keeled labrum.

Distribution

Japan (Sesoko Island, Okinawa).

Y-nauplius **Type AH***

Figs 2, 9I–N

Type AH* – Dreyer *et al.* 2023a: figs 4, 5a, c, tables s1–s2.

Material examined

JAPAN – **Okinawa, Sesoko I., laboratory pier, 26°38′09.4″ N, 127°51′55.2″ E** • 11 LSN; 1991–2005 • 31 LSN, 28 of which molted to cyprids; 2018–2019 (Tables 1 and S1).

Description

Last-stage nauplius (LSN). Lecithotrophic. Body spoon-shaped in dorso-ventral view; about twice as long as wide; cephalic shield widely ovate, with sharp discontinuity in body outline leading into trunk. In lateral view, trunk axis bent downwards 30–35° with respect to cephalic axis. Length 240–270 µm (ventral view in life, without dorso-caudal spine), greatest width 175 µm, greatest dorso-ventral thickness ca 110 µm. Labrum with goblet-shaped outline in ventral view, its free, rounded posterior margin being extended into medium-sized (15 µm long) medial spine (‘stem’ of ‘goblet’); labral surface divided into facets by cuticular ridges; pore pattern not examined. Caudal end attenuate, terminating in robust, 90 µm long dorso-caudal spine armed with smaller spines and accompanied ventrally at base by pair of triangular furcal spines ca 10 µm long; axis of dorso-caudal spine bent upwards at 30° with respect to trunk axis.

Cyprid viewed through cuticle of LSN. Body weakly brownish with many yolk granules/lipid vesicles concentrated dorsally, one typically being situated in midline anterior to nauplius eye, and with clusters of small vesicles posterior to compound eyes. Telson about as long as wide, about half as long as thorax.

Identification and variation

Recognizable by the combination of its general shape, the large, spinose dorso-caudal spine and the large, goblet-shaped labrum with a free posterior extension continuing into a median spine overhanging the mouth region. Little morphological variation is seen between specimens, most or all of which have internal lipid vesicles/yolk granules distributed as described above. Molecular diversity revealed by sequencing 13 specimens (Dreyer *et al.* 2023a) suggests that this naupliar morphospecies comprises three cryptic species.

Distribution

Japan (Sesoko Island, Okinawa).

Y-nauplius **Type E***

Figs 2, 10A–F

Hansenocaris sp. – Itô 1991: 57, fig. 1 (see the 'Itô's (1991) y-nauplius' portion of the Discussion below).
Nauplius of undescribed lecithotrophic y-larva – Grygier *et al.* 2019: 1226–1228, figs 2c–h, 3a–b.
Type E* – Dreyer *et al.* 2023a: figs 4, 5a, c, tables s1–s2.

Material examined

JAPAN – **Okinawa, Sesoko I., laboratory pier, 26°38′09.4″ N, 127°51′55.2″ E** • 9 LSN; 1991–2005 • 40 LSN, 29 of which molted to cyprids; 2018–2019 (Tables 1 and S1).

Description

Last-stage nauplius (LSN). Lecithotrophic. Body short-handled spoon-shaped in dorso-ventral view; about 1.5 times as long as wide; cephalic shield widely ovate, with sharp discontinuity in body outline leading into trunk. In lateral view, trunk axis bent downwards 50–60° with respect to cephalic axis. Length 210–260 µm (without dorso-caudal spine), greatest width 140–150 µm, greatest dorso-ventral thickness ca 80 µm. Labrum with pentagonal outline in ventral view; free posterior margin extending into 10 µm long median spine; surface divided into facets by cuticular ridges; pores not examined in detail, but at least with pair of postero-lateral pores. Caudal end attenuate, terminating in 40–50 µm long, often slightly curved dorso-caudal spine upturned 50° with respect to trunk axis and armed with spiny ornamentation and accompanied ventrally at base by pair of ca 7 µm long furcal spines.

Cyprid viewed through cuticle of LSN. Body weakly brownish-pigmented. Cephalon with one or two pairs of distinct yolk/lipid vesicles close to its anterior margin. Gut-like central tube often with brownish/reddish-colored yolk granules, especially in posterior part. Telson about as long as wide and less than half as long as thorax.

Identification and variation

Recognizable by the combination of its general body shape, pentagonal labral outline, relative slender and often curved dorso-caudal spine, and the pair of distinct yolk granules/vesicles at the anterior margin of the cephalic shield. Little morphological variation is seen between specimens. Molecular diversity revealed by sequencing 15 specimens (Dreyer *et al.* 2023a) suggests that this naupliar morphospecies includes two or three distinct species.

Distribution

Japan (Sesoko Island, Okinawa; Tanabe Bay, Wakayama).

Y-nauplius **AG***

Figs 2, 10G–K

Type AG* – Dreyer *et al.* 2023a: figs 4, 5a, c, tables s1–s2.

Material examined

JAPAN – **Okinawa, Sesoko I., laboratory pier, 26°38′09.4″ N, 127°51′55.2″ E** • 13 LSN; 1991–2005 • 27 LSN, 21 of which molted to cyprids; 2018–2019 (Tables 1 and S1).

Description

Last-stage nauplius (LSN). Lecithotrophic. Body spoon-shaped in dorso-ventral view; about 1.7 times as long as wide in ventral view; cephalic shield widely ovate, with sharp discontinuity in body outline leading into trunk. In lateral view, trunk axis bent downwards ca 35° with respect to cephalic axis. Length

270–280 µm (without dorso-caudal spine), greatest width ca 150 µm, greatest dorso-ventral thickness ca 100 µm. Labrum with round-cornered rectangular outline in ventral view; surface divided into facets by cuticular ridges and with midline keel extending posteriorly into 20 µm long median spine; pore pattern not examined in detail, but at least with pair of postero-lateral pores. Caudal end attenuate, terminating in ca 65 µm long, slightly dorsally curved dorso-caudal spine with weak sculpturing of minutely spinose cuticular rings; spine upturned 35° with respect to body axis and accompanied ventrally at base by pair of triangular furcal spines ca 5 µm long.

Cypride viewed through cuticle of LSN. Body unpigmented. Cephalon typically with one or two pairs of distinct yolk granules/vesicles close to anterior margin. Gut-like tube typically with two to four yolk granules in posterior part, one of which most often distinctly orange. Telson longer than wide and about half as long as thorax.

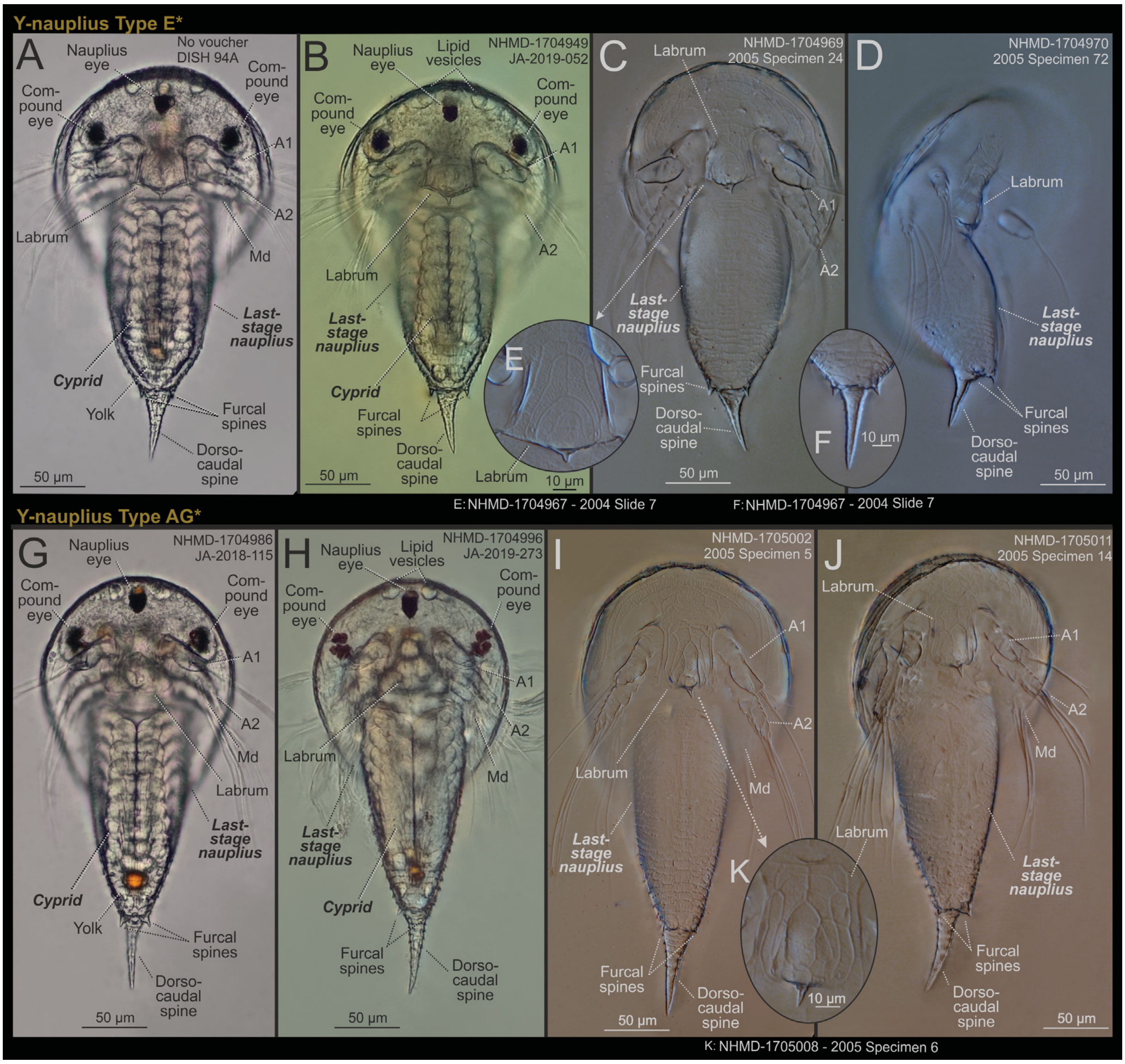

Fig. 10. Last-stage nauplii of two different morphospecies of y-larvae (Facetotecta) from Sesoko Island (Okinawa, Japan). **A–F**. Y-nauplius Type E*. **G–K**. Y-nauplius Type AG*. Shown either in life (A–B, G–H) or as slide-mounted exuviae (C–F, I–K). Abbreviations: A1 = first antenna; A2 = second antenna; Md = mandible.

Identification and variation

Recognizable by the combination of its general body shape, the rounded-quadrangular labral outline with a midline keel terminating in a small spine and the cyprid's relatively slender telson with orange yolk granules in its gut-like tube. Little variation is seen among specimens. The molecular diversity of eight sequenced specimens (Dreyer *et al.* 2023a) suggests that this naupliar morphospecies includes two distinct species.

Distribution

Japan (Sesoko Island, Okinawa).

Y-nauplius **Type W**

Figs 2, 11A–G

Material examined

JAPAN – **Okinawa, Sesoko I., laboratory pier, 26°38′09.4″ N, 127°51′55.2″ E** • 1 LSN; 1991–2005 • 9 LSN, 8 of which molted to cyprids; 2018–2019 (Tables 1 and S1).

Description

Last-stage nauplius (LSN). Lecithotrophic. Body spoon-shaped in dorso-ventral view; about 1.8 times as long as wide; cephalic shield circular/ellipsoidal, with discontinuity in body outline leading into trunk. In lateral view, body axis bent downwards 30° with respect to cephalic axis. Length ca 250 µm (without dorso-caudal spine), greatest width ca 130 µm, greatest dorso-ventral thickness ca 80 µm. Labrum balloon-shaped, with surface divided into facets by cuticular ridges, midline produced into keel-like elevation, and free posterior margin bearing small median spine; pores not examined. Caudal end attenuate, terminating in 75–80 µm long, slightly dorsally curved dorso-caudal spine bearing small spines; spine upturned ca 20° to trunk axis and accompanied ventrally at base by pair of ca 10 µm long triangular furcal spines.

Cyprid viewed through cuticle of LSN. Body overall weakly brownish-pigmented. Cephalon most often with two to four lipid vesicles along anterior margin and one to three laterally. Telson slightly longer than wide and about half as long as thorax, often with pair of distinct lipid vesicles.

Identification and variation

Recognizable by the combination of its general body shape, the balloon-shaped, keeled labrum with a spine on the posterior margin and the large, rather straight dorso-caudal spine flanked by relatively robust furcal spines. Variation is seen among nauplii in the form of the dorso-caudal spine (either broad-based and more or less straight or more slender and curved); in the morphology of the posterior margin of the labrum (spine sometimes absent/diminutive, margin sometimes weakly serrate); and among unmolted cyprids in the number of lipid vesicles.

Distribution

Japan (Sesoko Island, Okinawa).

Y-nauplius **Type AD**

Figs 2, 11H–M

Type AD – Dreyer *et al.* 2023a: figs 4, 5a, c, tables s1–s2.

Material examined

JAPAN – **Okinawa, Sesoko I., laboratory pier, 26°38′09.4″ N, 127°51′55.2″ E** • 10 LSN, 3 of which molted to cyprids; 2018–2019 (Tables 1 and S1).

Description

Last-stage nauplius (LSN). Lecithotrophic. Body short-handled spoon-shaped in dorso-ventral view; about 1.6 times as long as wide; cephalic shield ovate, with some discontinuity in body outline leading into trunk. In lateral view, trunk axis bent downwards ca 15–20° with respect to cephalic axis. Length 300–340 µm (ventral view in life, without dorso-caudal spine), greatest width 190–200 µm, greatest dorso-ventral thickness ca 100 µm. Labrum hoe-shaped in ventral view with free posterior margin; surface divided into facets by cuticular ridges; posterior half of labral midline with keel-like elevation extending into postero-median spine; pores not examined in detail, but one pair certainly present in left

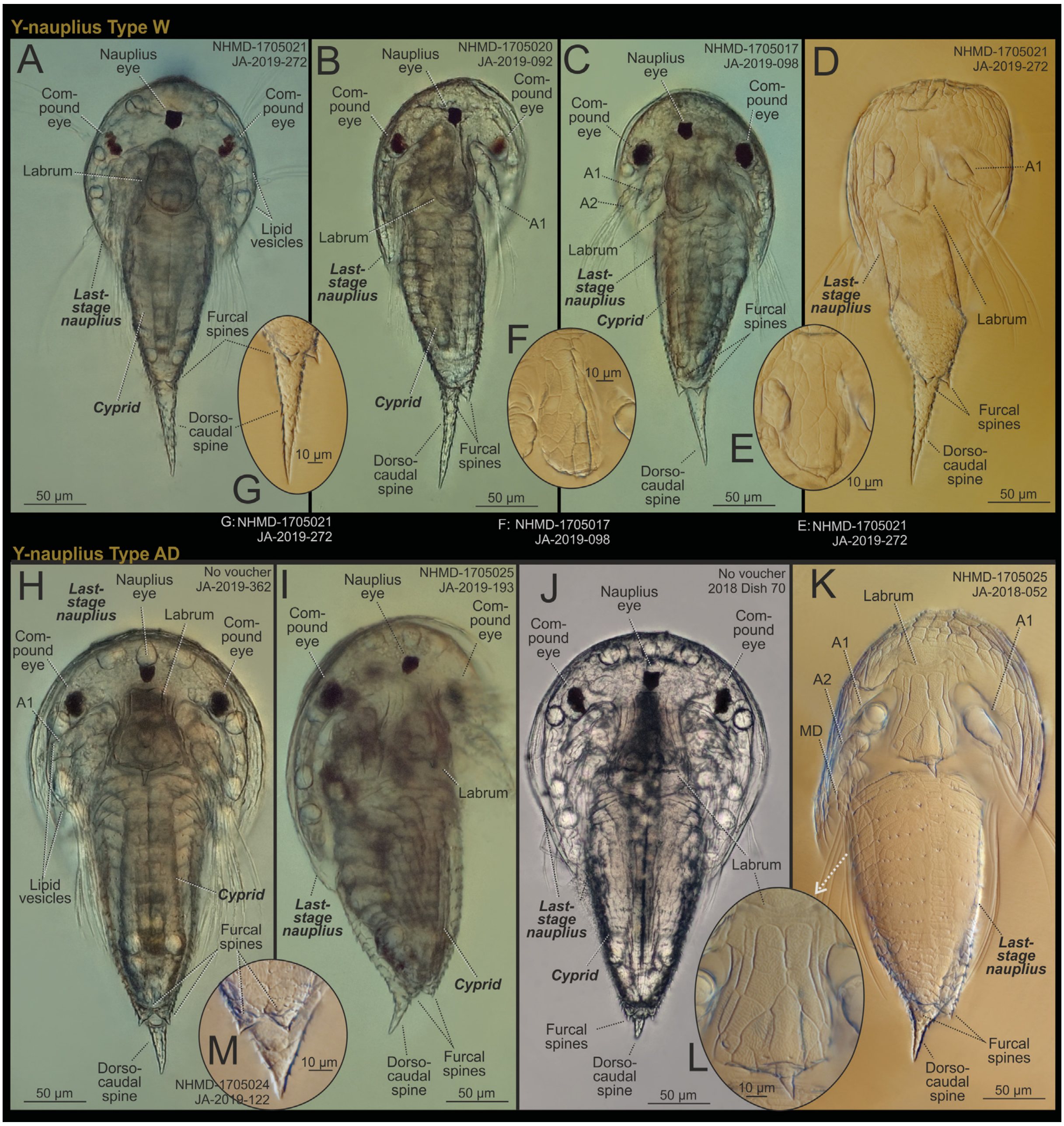

Fig. 11. Last-stage nauplii of two different morphospecies of y-larvae (Facetotecta) from Sesoko Island (Okinawa, Japan). **A–G**. Y-nauplius Type W. **H–M**. Y-nauplius Type AD. Shown either in life (A–C, H–J) or as slide-mounted exuviae (D–G, K–M). Abbreviations: A1 = first antenna; A2 = second antenna; Md = mandible.

and right postero-lateral corners. Caudal end attenuate, terminating in ca 35 µm long, dorsally inclined dorso-caudal spine upturned ca 35° relative to trunk axis and accompanied ventrally at base by pair of broad-triangular furcal spines ca 10 µm long.

Cyprid viewed through cuticle of LSN. Body overall weakly brownish-pigmented with more distinct brown/black pigmentation in labral region, lateral margins of thorax, and telson. Cephalon with about five lipid vesicles along anterior margin, about three along each lateral margin.

Identification and variation

Easily recognizable by the combination of its general body shape, the large number of lipid vesicles along the cephalic shield's margin, the hoe-shaped labrum and the relatively short and broad dorso-caudal spine.

Distribution

Japan (Sesoko Island, Okinawa).

Y-nauplius **Type U***

Figs 2, 12A–D

Type U* – Dreyer *et al.* 2023a: figs 4, 5a, c, tables s1–s2. — Olesen *et al.* 2024: fig. 2f–g.

Material examined

JAPAN – **Okinawa, Sesoko I., laboratory pier, 26°38′09.4″ N, 127°51′55.2″ E** • 1 LSN; 1991–2005 • 1 LSN; 2018–2019 (Tables 1 and S1).

Description

Last-stage nauplius (LSN). Lecithotrophic. Body widely ovate in dorso-ventral view; about 1.4 times as long as wide; cephalic shield nearly circular, with minor discontinuity in body outline leading into trunk. In lateral view, longitudinal axes of cephalon, trunk and dorso-caudal spine all in approximately same plane. Length 460 µm (ventral view in life, without dorso-caudal spine), greatest width ca 330 µm, greatest dorso-ventral thickness ca 30 µm. Labrum shorter than wide, a nearly rectangular low elevation weakly divided into facets by cuticular ridges; bearing four pores, two in midline posteriorly and pair situated outside of left and right ridge-defined labral margins. Lateral margins of trunk bearing spine rows. Caudal end obtuse, terminating in 75 µm long dorso-caudal spine with at least three annular ridges bearing several subsidiary spines, accompanied ventrally and slightly forward of its base by pair of tiny, vestigial furcal spines.

Cyprid viewed through cuticle of LSN. Occupying only central part of LSN near midline, leaving large fraction of outer portions of disc 'empty'. Lacking distinct pigmentation, except for some small dark pigment spots in telson. Yolk granules of gut-like central tube mostly concentrated in telson. Lipid vesicles present anteriorly and laterally in cephalon. Telson about as long as wide and about half as long as thorax.

Identification and variation

Easily recognizable by its flat 'disc-shaped' form (the broadest of the lecithotrophic y-nauplii encountered at Sesoko Island) and the central position of the developing cyprid within.

Distribution

Japan (Sesoko Island, Okinawa); Taiwan (Keelung).

Remarks

Itô (1987b: figs 1–3) described three forms of wide, flat y-nauplii (Types VIIIa-c) from Tanabe Bay (Japan: Wakayama Prefecture) that are the closest described forms in the literature to Type U* from

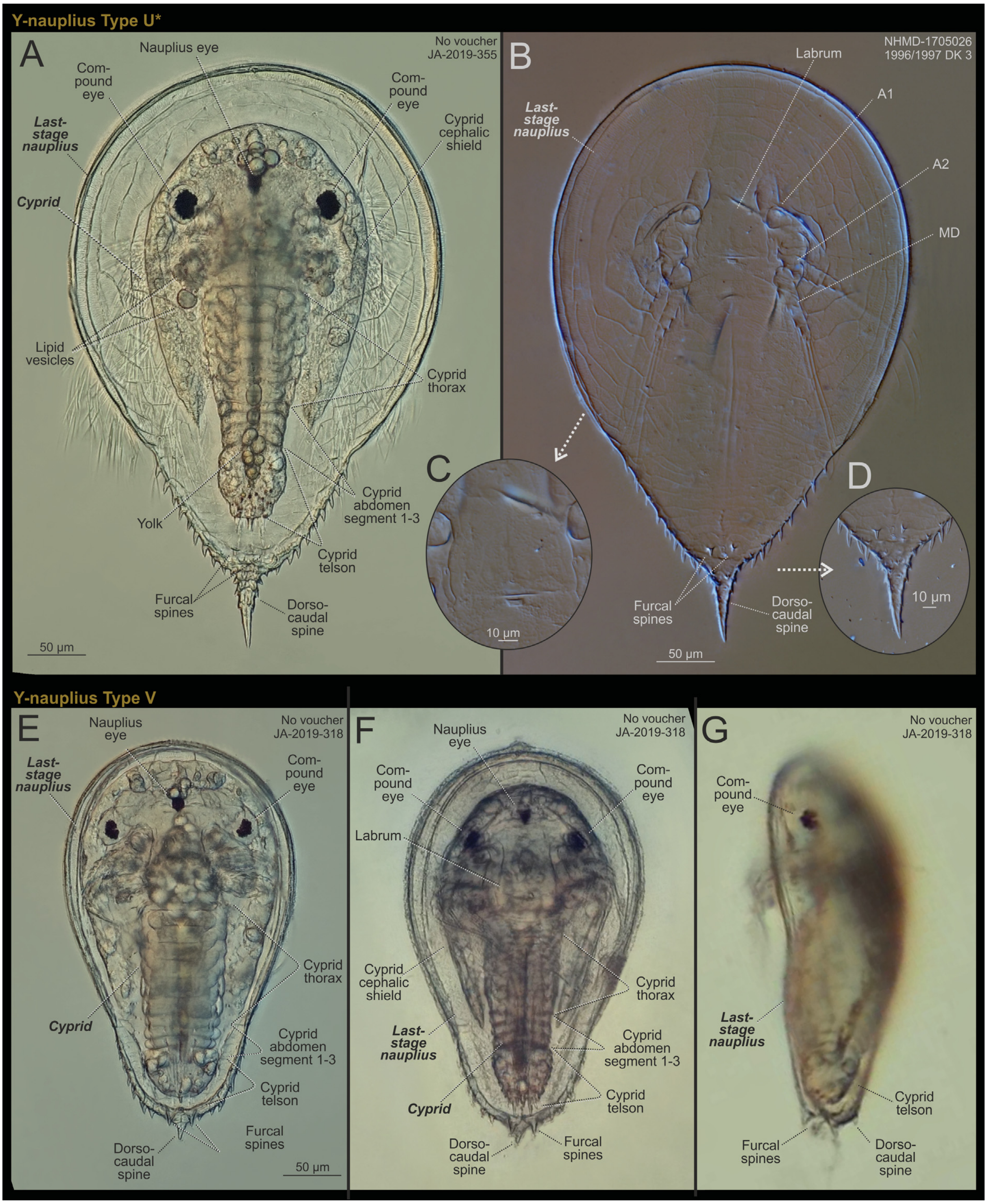

Fig. 12. Last-stage nauplii of two different morphospecies of y-larvae (Facetotecta) from Sesoko Island (Okinawa, Japan). **A–D**. Y-nauplius Type U*. **E–G**. Y-nauplius Type V. Shown either in life (A, E–G) or as slide-mounted exuviae (B–D). Abbreviations: A1 = first antenna; A2 = second antenna; Md = mandible.

Okinawa. Although they differ from Type U* in having antero-lateral indentations in the body margin, they might be earlier instars of either Type U* or something closely related to it. Because detailed morphological and molecular comparison with Itô's material has not been done, we do not treat any of these forms as synonymous here.

Y-nauplius **Type V**

Figs 2, 12E–G

Type V – Dreyer *et al.* 2023a: figs 4, 5a, c, tables s1–s2.

Not Nauplius V – Hansen 1899: 47–49, table 3, fig. 6. — Schram 1970: 53, 64.

Material examined

JAPAN – **Okinawa, Sesoko I., laboratory pier, 26°38′09.4″ N, 127°51′55.2″ E** • 1 LSN; 1991–2005 • 2 LSN, 1 of which molted to a cyprid; 2018–2019 (Tables 1 and S1).

Description

LAST-STAGE NAUPLIUS (LSN). Lecithotrophic. Body narrowly ovate in dorso-ventral view; about 1.6 times as long as wide; lateral margins tapering gradually towards caudal end with indistinct concave transition between cephalic shield and trunk. In lateral view, body almost straight, with trunk axis downturned ca 10–15° with respect to cephalic axis. Length 340–370 µm (without dorso-caudal spine), greatest width ca 230 µm, greatest dorso-ventral thickness ca 100 µm. Labrum not examined in detail. Lateral margins of trunk with rows of 5–10 µm long spines. Caudal end rounded and terminating in fairly sharply pointed, 10–15 µm long dorso-caudal spine accompanied ventrally by similarly sharp pair of ca 10 µm long, triangular furcal spines.

CYPRID VIEWED THROUGH CUTICLE OF LSN. Body overall transparent, but rows of brown pigment spots present along lateral margins of cephalon early in cyprid development, with more extensive brownish coloration developing later on. Gut-like tube packed with yolk granules along most of its length. Lipid vesicles clustered in mouth/labrum region of cephalon, with a few more present anterior to nauplius eye. In early LSN, telson wider than long and about half as long as thorax, but more elongate in later-phase LSN.

Identification and variation

Easy recognizable by its overall disc-shaped body, spine-lined trunk margins and broadly rounded caudal end with a relatively small dorso-caudal spine. The two examined specimens differ somewhat in size (Table S1), and only the larger one has rows of pigment spots along the margins of the developing cyprid's cephalon.

Distribution

Japan (Sesoko Island, Okinawa).

Y-nauplius **Type X**

Figs 2, 13A–E

Type X – Dreyer *et al.* 2023a: figs 4, 5a, c, tables s1–s2. — Olesen *et al.* 2024: fig. 3d–e.
En levende nauplius-y – Høeg 2005: 18, unnumbered LM photograph.

Not Type X – Itô 1987a: 913, 916–917, fig. 2a. — Kikuchi *et al*. 1991: 69, 72–73, tables 1, 3, fig. 2b. — Watanabe *et al.* 2000: 7, 9, fig. 5. — Kolbasov & Høeg 2003: 3, 13.

Material examined

JAPAN – **Okinawa, Sesoko I., laboratory pier, 26°38′09.4″ N, 127°51′55.2″ E** • 1 LSN; 1991–2005 • 9 LSN, 3 of which molted to cyprids; 2018–2019 (Tables 1 and S1).

Description

Last-stage nauplius (LSN). Lecithotrophic. Body elongate-ovate in dorso-vental view, i.e., racket- or snowshoe-shaped, about 1.7 times as long as wide (excluding dorso-caudal spine); cephalic shield ovate/ellipsoidal, with no discontinuity in lateral body outline between shield and trunk. In lateral view, longitudinal axes of cephalon, trunk and dorso-caudal spine all approximately in same plane. Length 330–360 µm (ventral view in life, without dorso-caudal spine), greatest width ca 220 µm, dorso-ventral thickness not measured. Labrum produced as low, nearly square elevation, posterior two-thirds of which trapezoidal owing to lateral insertions of first and second antennae; surface weakly divided into facets by cuticular ridges; pore pattern not studied in detail. Caudal end attenuate/acuminate, terminating without marked discontinuity in broad-based ca 100 µm long, multi-annulate and heavily spinose dorso-caudal spine accompanied ventrally by pair of triangular furcal spines ca 10 µm long.

Cyprid viewed through cuticle of LSN. Body overall transparent but with brownish pigmentation appearing later in LSN phase. In early-phase LSN, lateral margins of cyprid's cephalon with clusters of crystal-like particles and gut-like tube packed with brown/white yolk granules, those in telson being orange in some specimens. Telson about as wide as long and half as long as thorax during early phase of LSN, becoming more elongate later.

Identification and variation

Easily recognizable by its large size and snowshoe- or racket-shaped body. Little variation is apparent among LSN specimens.

Distribution

Japan (Sesoko Island, Okinawa).

Y-nauplius **Type K**

Figs 2, 5D–F, 13F–J

Type K – Dreyer *et al.* 2023a: figs 3, 5a, c, tables s1–s2.

Material examined

JAPAN – **Okinawa, Sesoko I., laboratory pier, 26°38′09.4″ N, 127°51′55.2″ E** • 5 LSN; 1991–2005 • 27 LSN, 6 of which molted to cyprids; 2018–2019 (Tables 1 and S1).

Description

Last-stage nauplius (LSN). Lecithotrophic. Body widely ovate in dorso-ventral view; about 1.3 times as long as wide; cephalic shield very wide-ovate, with some discontinuity in body outline leading into trunk. In lateral view, trunk axis downturned ca 55° with respect to cephalic axis. Length 190–220 µm (ventral view in life, without dorso-caudal spine), greatest width ca 140 µm, greatest dorso-ventral thickness ca 65 µm. Labrum produced as sub-trapezoidal elevation with surface divided into facets by cuticular ridges; bearing total of five pores: three near midline posteriorly and one postero-lateral pair along left and right labral margins. Caudal end truncate, terminating in simple, ca 5 µm long dorso-caudal spine, this upturned ca 10° relative to trunk axis and flanked ventrally by pair of triangular furcal spines ca 10 µm long.

Cyprid viewed through cuticle of LSN. Body generally transparent or weakly brownish. Cephalic shield often with a few small, transparent lipid vesicles along anterior margin. Posterior part of gut-like tube containing small, orange yolk granules. Telson twice as long as wide and significantly shorter than thorax, often not clearly demarcated from latter.

Identification and variation

Recognizable by the combination of its short, compact body, truncate caudal end and very small dorso-caudal spine. No significant variation recognized among specimens. Type K is the smallest lecithotrophic morphospecies treated in this work.

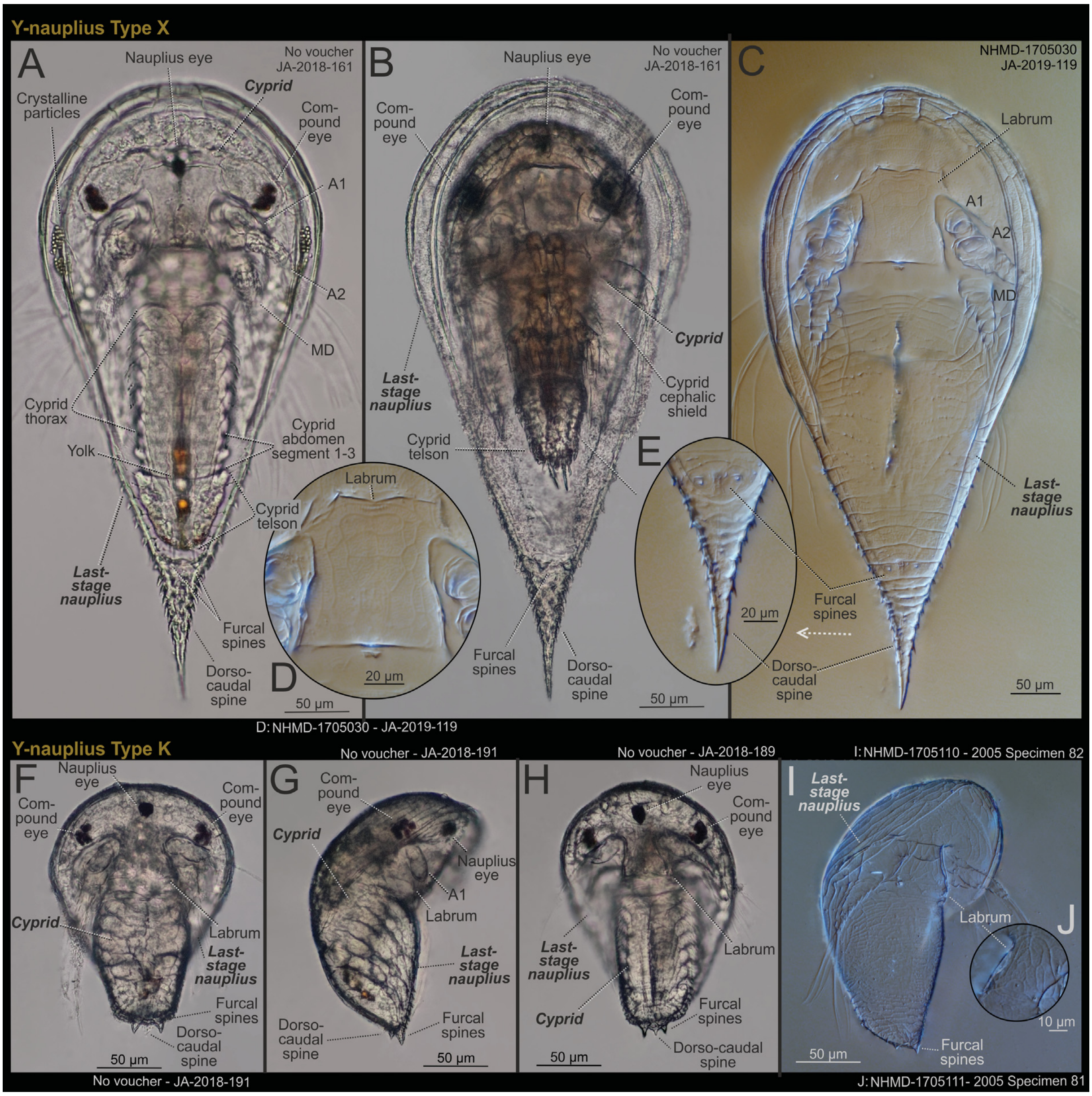

Fig. 13. Last-stage nauplii of two different morphospecies of y-larvae (Facetotecta) from Sesoko Island (Okinawa, Japan). **A–E**. Y-nauplius Type X. **F–J**. Y-nauplius Type K. Shown either in life (A–B, F–H) or as slide-mounted exuviae (C–E, I–J). Abbreviations: A1 = first antenna; A2 = second antenna; Md = mandible.

Distribution

Japan (Sesoko Island, Okinawa).

Y-nauplius **Type M**

Figs 2, 14A–F

Type M – Dreyer *et al.* 2023a: figs 3, 5a, c, tables s1–s2.

Material examined

JAPAN – **Okinawa, Sesoko I., laboratory pier, 26°38′09.4″ N, 127°51′55.2″ E** • 3 LSN; 1991–2005 • 6 LSN, 3 of which molted to cyprids; 2018–2019 (Tables 1 and S1).

Description

LAST-STAGE NAUPLIUS (LSN). Lecithotrophic. Body narrowly ovate, almost lanceolate, in dorso-ventral view; about 2.0 times as long as wide; lateral margins without marked discontinuity between cephalic shield and trunk. In lateral view, trunk axis bent ca 30° downwards with respect to cephalic axis. Length 290–310 µm (without dorso-caudal spine), greatest width ca 150 µm, greatest dorso-ventral thickness ca 90 µm. Labrum produced as sub-triangular, nearly semi-circular elevation divided into facets by cuticular ridges; pore pattern not examined in detail but at least 2–3 pores present along posterior half of midline. Caudal end attenuate, terminating in ca 60 µm long, annulate but not obviously spiny dorso-caudal spine, this being turned upwards 30° with respect to trunk axis and accompanied ventrally by pair of triangular furcal spines ca 7–10 µm long.

CYPRID VIEWED THROUGH CUTICLE OF LSN. Body overall weakly brownish with distinctly darker-brown telson. Telson portion of gut-like tube containing orange yolk granules. Telson longer than wide and about half as long as thorax.

Identification and variation

Easy recognizable by its general body form, labral outline, long and annulate but not obviously spinose dorso-caudal spine and the distinct brown pigmentation of the cyprid's telson. Little variation is evident among LSN specimens.

Distribution

Japan (Sesoko Island, Okinawa).

Y-nauplius **Type AI**

Figs 2, 14G–L

Material examined

JAPAN – **Okinawa, Sesoko I., laboratory pier, 26°38′09.4″ N, 127°51′55.2″ E** • 2 LSN; 1991–2005 • 8 LSN, 6 of which molted to cyprids; 2018–2019 (Tables 1 and S1).

Description

LAST-STAGE NAUPLIUS (LSN). Lecithotrophic. Body narrowly ovate in dorso-ventral view; about 1.6 times as long as wide; lateral margins with only modest discontinuity in body outline between cephalic shield and trunk. In lateral view, trunk axis bent downwards ca 10–20° with respect to cephalic axis. Length 210–240 µm (without dorso-caudal spine), greatest width ca 120 µm, greatest dorso-ventral thickness ca 80 µm. Labrum weakly elevated, hoe-shaped in ventral view, approximately 1.2 times as long as wide; surface divided into plates by cuticular ridges; pore pattern not examined in detail but at least three pores present in midline: one anteriorly, two posteriorly. Caudal end acuminate, terminating in ca 30 µm long dorso-caudal spine usually with two or three annuli, this being upturned ca 10–20°

with respect to trunk axis and accompanied ventrally by pair of furcal double-spines ca 5 µm long (i.e., each furcal spine bifid from base).

Cyprid viewed through cuticle of LSN. Body overall weakly brownish, but telson and anterior part of cephalon distinctly darker brown. Gut-like central tube and central part of cephalon packed with yolk granules/lipid vesicles and often with orange-colored vesicle in telson. Telson sub-triangular, about as long as wide, about half as long as thorax.

Identification and variation

Easily recognizable by its overall shape and size, furcal double-spines, relatively small dorso-caudal spine and the developing cyprid's brown telson. Variation is evident in the size of the dorso-caudal spine.

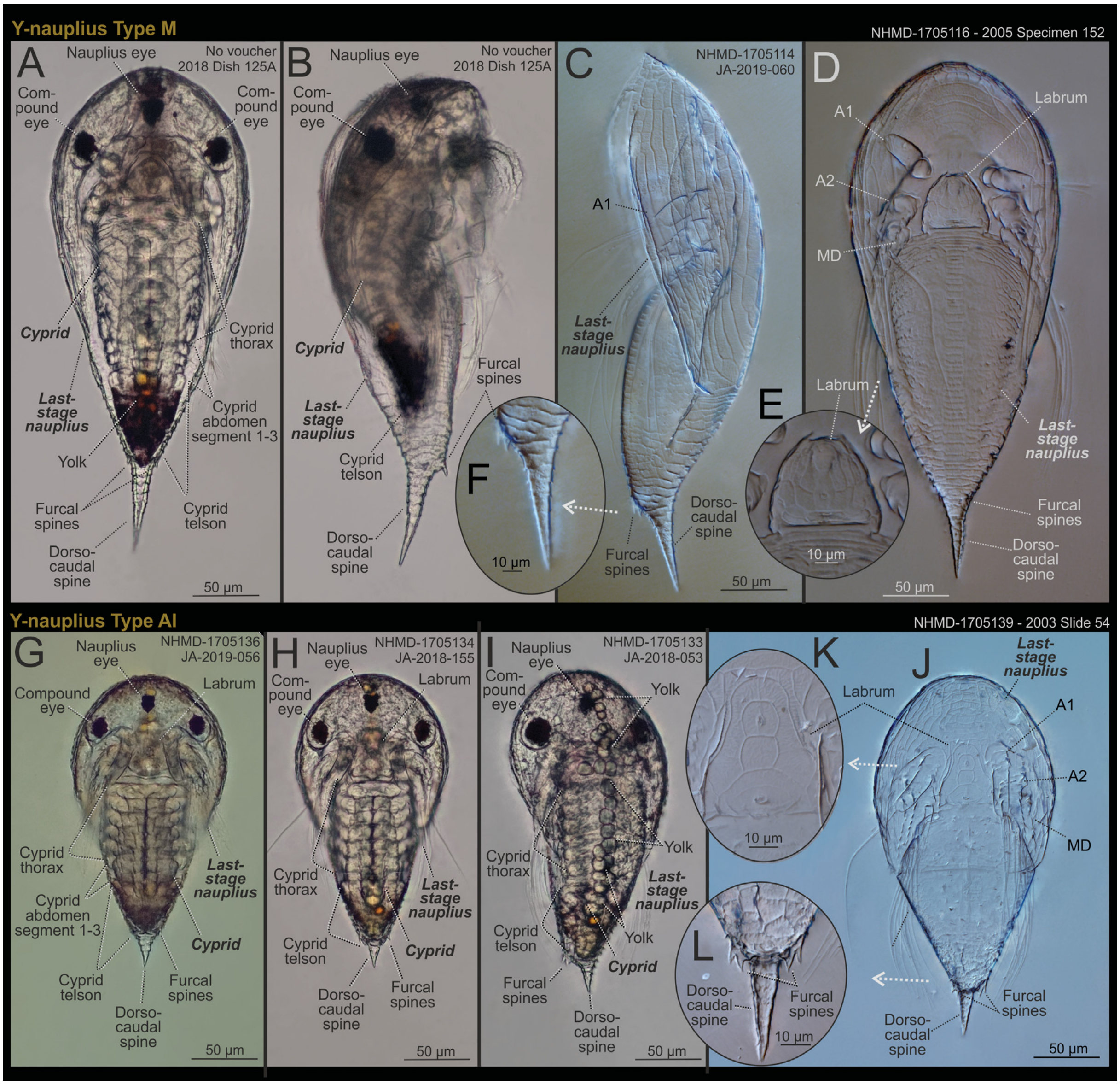

Fig. 14. Last-stage nauplii of two different morphospecies of y-larvae (Facetotecta) from Sesoko Island (Okinawa, Japan). **A–F**. Y-nauplius Type M. **G–L**. Y-nauplius Type AI. Shown either in life (A–B, G–I) or as slide-mounted exuviae (C–F, J–L). Abbreviations: A1 = first antenna; A2 = second antenna; Md = mandible.

Distribution

Japan (Sesoko Island, Okinawa).

Y-nauplius **Type L**

Figs 2, 15A–F

Type L – Dreyer *et al.* 2023a: figs 3, 5a, c, tables s1–s2.

Material examined

JAPAN – **Okinawa, Sesoko I., laboratory pier, 26°38′09.4″ N, 127°51′55.2″ E** • 8 LSN, 3 of which molted to cyprids; 2018–2019 (Tables 1 and S1).

Description

Last-stage nauplius (LSN). Lecithotrophic. Body narrowly ovate, almost lanceolate in dorso-ventral view; about 1.8 times as long as wide; lateral margins without marked discontinuity in body outline between cephalic shield and trunk. In lateral view, trunk axis downturned 20° with respect to cephalic axis. Length 270–290 µm (of short form, see below) (without dorso-caudal spine), greatest width ca 150 µm, greatest dorso-ventral thickness ca 100 µm. Labrum produced as nearly equilateral subtriangular elevation; divided into facets by cuticular ridges; pore pattern not examined in detail but three pores present in midline. Caudal end attenuate, terminating in ca 50–60 µm long, basally annulate but essentially smooth dorso-caudal spine, this being bent slightly upwards (5°) with respect to trunk axis and accompanied ventrally by pair of small, pointed furcal spines ca 6–7 µm long.

Cyprid viewed through cuticle of LSN. Body overall with strong brown pigmentation. Telson portion of gut-like tube with orange yolk granules. Telson longer than wide and more than half as long as thorax.

Identification and variation

Recognizable by the combination of its general shape, small furcal spines and strong brown pigmentation. Four specimens are ca 270 µm long, but four others are 360–380 µm long with more robust dorso-caudal spines than the smaller ones, suggesting that this morphospecies may consist of two separate species.

Distribution

Japan (Sesoko Island, Okinawa).

Y-nauplius **Type AB**

Figs 2, 15G–M

Undescribed form-taxa of lecithotrophic y-larvae – Grygier *et al.* 2019 pars: 1228, fig. 3g.
Type AB – Dreyer *et al.* 2023a: figs 4, 5a, c, tables s1–s2. — Olesen *et al.* 2024: fig. 3b.

Material examined

JAPAN – **Okinawa, Sesoko I., laboratory pier, 26°38′09.4″ N, 127°51′55.2″ E** • 3 LSN; 1991–2005 • 9 LSN, 7 of which molted to cyprids; 2018–2019 (Tables 1 and S1).

Description

Last-stage nauplius (LSN). Lecithotrophic. Body dipper-shaped/ovate in dorso-ventral view, about 1.6 times as long as wide; cephalic shield widely ovate, with sharp discontinuity in body outline leading into trunk. In lateral view, trunk axis downturned ca 50° with respect to cephalic axis. Length 210–240 µm (ventral view in life, without dorso-caudal spine), greatest width ca 150 µm, greatest dorso-ventral thickness ca 90–100 µm. Labrum elevated, spatulate in outline; surface divided into facets by cuticular ridges; with free posterior margin; pore pattern not examined in detail but one in midline posteriorly and a pair in postero-lateral corners. Caudal end obtuse, terminating in small, robust broad-conical, ca 5–10 µm long dorso-caudal spine, its axis upturned 20–30° with respect to trunk axis, this spine being accompanied ventrally by pair of even smaller, broad-conical furcal spines approximately 2–3 µm long.

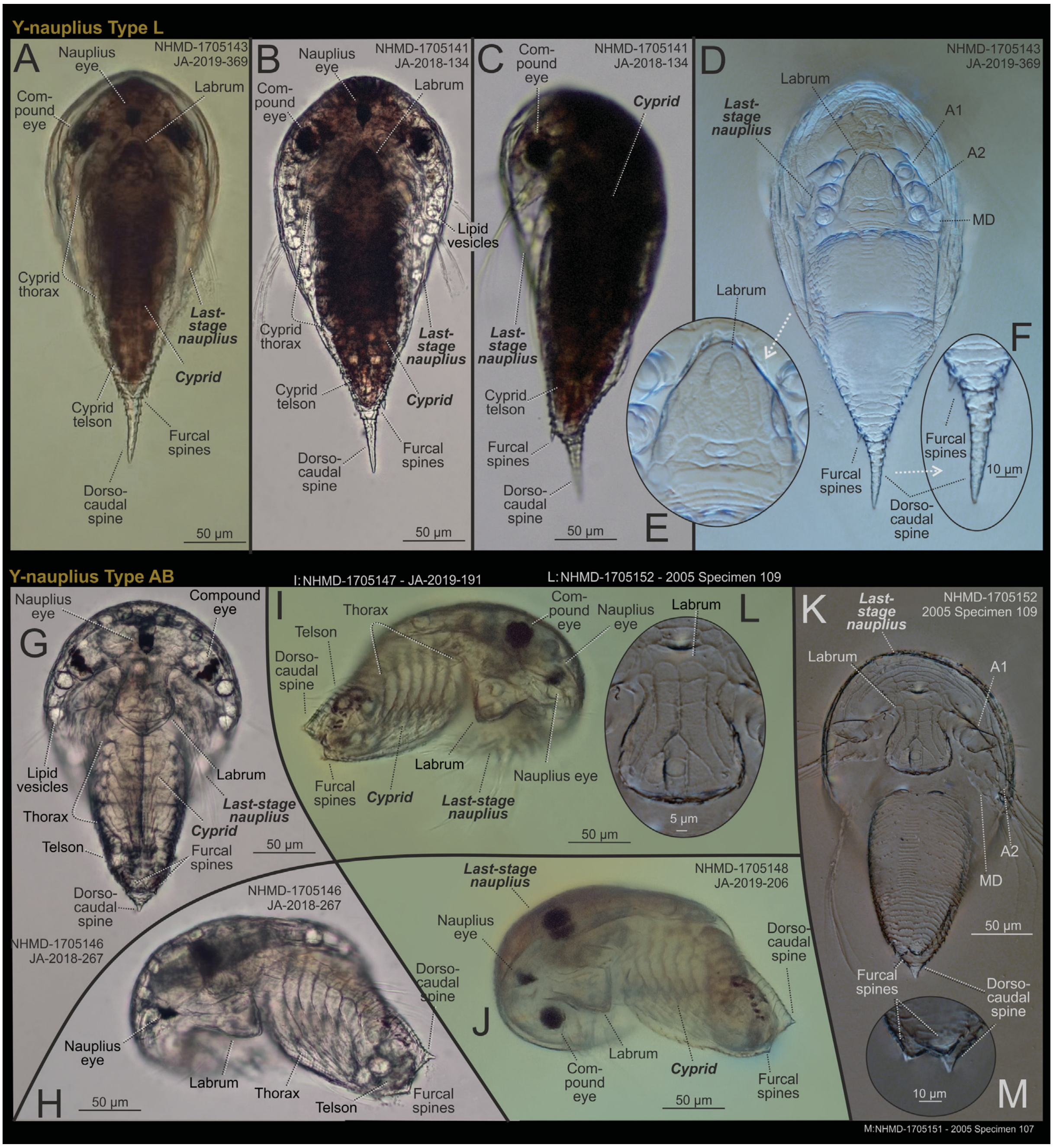

Fig. 15. Last-stage nauplii of two different morphospecies of y-larvae (Facetotecta) from Sesoko Island (Okinawa, Japan). **A–F**. Y-nauplius Type L. **G–M**. Y-nauplius Type AB. Shown either in life (A–C, G–J) or as slide-mounted exuviae (D–F, K–M). Abbreviations: A1 = first antenna; A2 = second antenna; Md = mandible.

CypriD viewed through cuticle of LSN. Body overall weakly brownish, but telson with brown/black spots arranged in rows and circles and gut-like tube packed with yellowish and orange yolk granules. Cephalic shield with lipid vesicles along lateral margins (3–4 on each side) and frontal margin (about 4).

Identification and variation

Easily recognizable by the combination of its compact form, spatulate labrum, short dorso-caudal spine and the brown-spotted pigmentation of the developing cyprid’s telson. At least one specimen has a larger dorso-caudal spine than the others.

Distribution

Japan (Sesoko Island, Okinawa).

Y-nauplius **Type Y**

Figs 2, 16A–E

Type Y – Dreyer *et al.* 2023a: figs 4, 5a, c, tables s1–s2.

Material examined

JAPAN – **Okinawa, Sesoko I., laboratory pier, 26°38′09.4″ N, 127°51′55.2″ E** • 4 LSN; 1991–2005 • 4 LSN; 2018–2019 (Tables 1 and S1).

Description

Last-stage nauplius (LSN). Lecithotrophic. Body ovate in dorso-ventral view; about 1.6 times as long as wide; lateral margins without discontinuity in body outline between cephalic shield and trunk. In lateral view, longitudinal axes of cephalon, trunk and dorso-caudal spine nearly in same plane. Length 360–400 µm (without dorso-caudal spine), greatest width ca 240 µm, greatest dorso-ventral thickness ca 150 µm. Labrum produced as wide, nearly square, trapezoidal elevation divided into facets by cuticular ridges; with four pores, two in posterior midline and pair along postero-lateral margins. Caudal end attenuate, terminating in 80–90 µm long, spinulose dorso-caudal spine accompanied ventrally by pair of tiny furcal spines situated slightly forward of its base.

Cyprid viewed through cuticle of LSN. In early-phase LSN, developing cyprid filling entire nauplius, but distinct ‘empty’ area present later on between cyprid and LSN’s lateral margins. Telson with dark-brown tip. Gut-like central tube with row of yolk granules, some colored orange: yolk granules/lipid vesicles clustered in central part of cephalon; lipid vesicles present anteriorly in cephalon. Telson about as long as wide and about half as long as thorax.

Identification and variation

Easily recognizable by its large size and racket-shaped body (in dorso-ventral view), with a clearer distinction between the trunk and the dorso-caudal spine than in Type X. Size variation among specimens is probably attributable, at least in part, to squeezing and distortion of exuviae during mounting on slides.

Distribution

Japan (Sesoko Island, Okinawa).

Y-nauplius **Type O***

Figs 2, 16F–J

Type O* – Dreyer *et al.* 2023a: figs 3, 5a, c, tables s1–s2.

Material examined

JAPAN – **Okinawa, Sesoko I., laboratory pier, 26°38′09.4″ N, 127°51′55.2″ E** • 5 LSN; 1991–2005 • 66 LSN, 11 of which molted to cyprids; 2018–2019 (Tables 1 and S1).

Description

Last-stage nauplius (LSN). Lecithotrophic. Body ovate in dorso-ventral view; about 1.6 times as long as wide, with lateral margins showing slight concavity at transition from cephalic shield to trunk. In

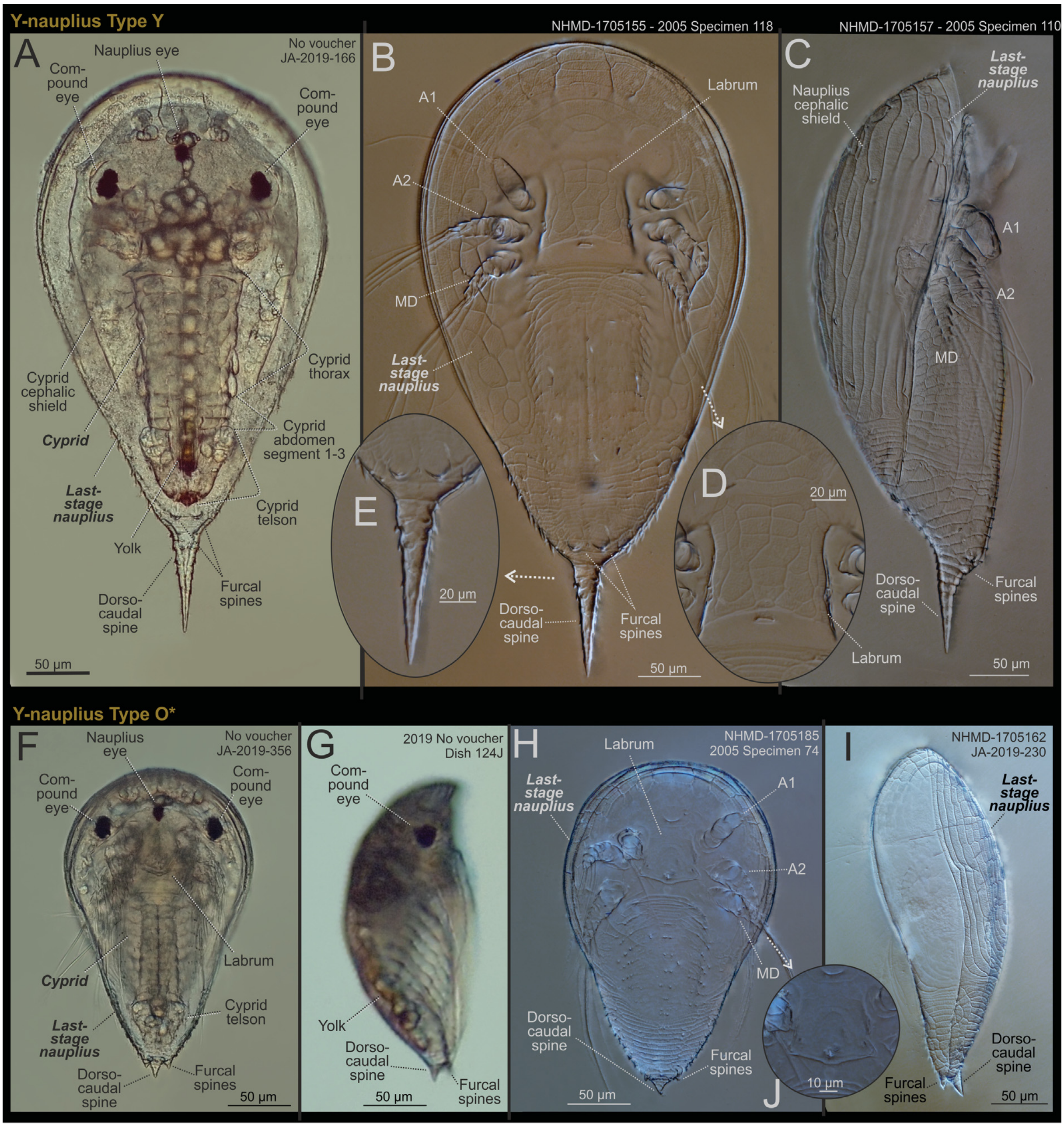

Fig. 16. Last-stage nauplii of two different morphospecies of y-larvae (Facetotecta) from Sesoko Island (Okinawa, Japan). **A–E**. Y-nauplius Type Y. **F–J**. Y-nauplius Type O*. Shown either in life (A, F–G) or as slide-mounted exuviae (B–E, H–J). Abbreviations: A1 = first antenna; A2 = second antenna; Md = mandible.

lateral view, trunk axis downturned ca 40° with respect to cephalic axis. Length 240–280 µm (without dorso-caudal spine), greatest width ca 150 µm, greatest dorso-ventral thickness ca 100 µm. Labrum produced as sub-trapezoidal elevation divided into facets by cuticular ridges; pores not examined in detail, but at least two in posterior half of midline and one pair in postero-lateral corners. Caudal end nearly acute, terminating in smooth, pointed, ca 20 µm long dorso-caudal spine with axis upturned 25° relative to trunk axis, this spine being accompanied ventrally by pair of triangular, ca 5–10 µm long furcal spines.

Cypríd viewed through cuticle of LSN. Body overall transparent but with weakly orange- or brown-colored yolk granules in central gut-like tube. Typically with pair of transparent vesicles along anterior margin of cephalic shield. Telson approximately as long as wide and about half as long as thorax, with pair of transparent vesicles anteriorly.

Identification and variation

Recognizable by the combination of its ovate/triangular body shape and its small size, general transparency and small caudal spines. Some variation among specimens in body size, length-width ratio and precise size of the caudal spines suggests that this morphospecies may include more than one species.

Distribution

Japan (Sesoko Island, Okinawa).

Y-nauplius **Type AF**

Figs 2, 17A–E

Undescribed form-taxa of lecithotrophic y-larvae – Grygier *et al.* 2019 pars: 1228, fig. 3f.
Type AF – Dreyer *et al.* 2023a: figs 4, 5a, c, tables s1–s2. — Olesen *et al.* 2024: fig. 2c.

Material examined

JAPAN – **Okinawa, Sesoko I., laboratory pier, 26°38′09.4″ N, 127°51′55.2″ E** • 2 LSN; 1991–2005 • 12 LSN, 8 of which molted to cyprids; 2018–2019 (Tables 1 and S1).

Description

Last-stage nauplius (LSN). Lecithotrophic. Body short, with unusually bloated trunk region; widely ovate in dorso-ventral view; about 1.35 times as long as wide; cephalic shield very widely ovate, with sharp discontinuity in body outline leading into trunk. In lateral view, trunk axis downturned ca 60° with respect to cephalic axis. Length 210–240 µm (ventral view in life, without dorso-caudal spine), greatest width ca 170 µm, greatest dorso-ventral thickness ca 130 µm. Labrum conical in lateral view and drawn into hypodermic-needle like distal extension; other features of labrum not examined. Caudal end truncate, terminating in broad, conical, ca 40 µm long dorso-caudal spine directed postero-dorsally, with its axis upturned ca 50° from trunk axis, and ventral pair of triangular furcal spines ca 5 µm long, these being widely separated both from each other and from dorso-caudal spine, sitting on distinct, conical bases.

Cyprid viewed through cuticle of LSN. Overall weakly brownish, but more distinctly brown in telson region. Gut-like tube filled with yolk granules; some of these partly brown or black but those in telson often colored orange; some specimens with additional lipid vesicles spread out within cephalon and smaller vesicles behind compound eyes. Telson small.

Identification and variation

Easily recognizable by its bloated or blimp-like form, conical labrum with hypodermic-needle-like extension and extremely robust, conical dorso-caudal spine. Some variation exists in the size of the dorso-caudal spine and its angle of orientation with respect to the trunk axis.

Distribution

Japan (Sesoko Island, Okinawa).

Y-nauplius **Type N***

Figs 2, 17F–I

Type N* – Dreyer *et al.* 2023a: figs 3, 5a, c, tables s1–s2.

Material examined

JAPAN – **Okinawa, Sesoko I., laboratory pier, 26°38′09.4″ N, 127°51′55.2″ E** • 1 LSN; 1991–2005 • 19 LSN, 8 of which molted to cyprids; 2018–2019 (Tables 1 and S1).

Description

LAST-STAGE NAUPLIUS (LSN). Lecithotrophic. Body ovate in dorso-ventral view; about 1.6 times as long as wide; lateral margins with only little discontinuity in body outline between cephalic shield and trunk. In lateral view, trunk axis downturned 45° with respect to cephalic axis. Length 220–240 µm (without dorso-caudal spine), greatest width ca 150 µm, greatest dorso-ventral thickness ca 70 µm. Labrum produced as sub-trapezoidal elevation; surface divided into facets by cuticular ridges; pores not examined in detail but at least with one pore in posterior half of midline and additional pair of pores in postero-lateral corners. Caudal end nearly acute, terminating in ca 20 µm long, robust, conical dorso-caudal spine, axis of which upturned 25° with respect to trunk axis, and pair of triangular furcal spines ca 5 µm long.

CYPRID VIEWED THROUGH CUTICLE OF LSN. Body generally transparent but many specimens with brown telson. Cephalic shield typically with 2–3 pairs of transparent lipid vesicles along lateral margins and 1–2 smaller pairs along frontal margin. Telson triangular, approximately as long as wide, about half as long as thorax.

Identification and variation

Recognizable by the combination of its ovate/triangular shape in ventral view, degree of bending between cephalon and trunk (bent more than Type O*) and robust, conical dorso-caudal spine. Variation was noted in developing cyprids; a few lack brown coloration of the telson or have fewer vesicles than usual along the cephalic margin.

Distribution

Japan (Sesoko Island, Okinawa).

Y-nauplius **Type AP**

Figs 2, 17L

Undescribed form-taxa of lecithotrophic y-larvae – Grygier *et al.* 2019 pars: 1228, fig. 3e.

Material examined

JAPAN – **Okinawa, Sesoko I., laboratory pier, 26°38′09.4″ N, 127°51′55.2″ E** • 1 LSN; 1991–2005 (Tables 1 and S1).

Description

Last-stage nauplius (LSN). Lecithotrophic. Body shape not examined in dorso-ventral view, but cephalic shield apparently ovate with sharp discontinuity leading into trunk. In lateral view, trunk axis downturned 40° with respect to cephalic axis. Length 300 µm (lateral view of mounted exuvia) (without dorso-caudal spine), greatest width unknown, greatest dorso-ventral thickness ca 110 µm. Labrum strongly produced and divided into facets by cuticular ridges, with row of three successively longer spines on distal midline. Caudal end truncate, terminating in robust, conical, ca 30 µm long dorso-caudal spine, its axis upturned 35° relative to trunk axis. Thick, triangular furcal spines situated ventrally far from dorso-caudal spine, ca 5–10 µm long.

Cypria viewed through cuticle of LSN. No live specimen examined.

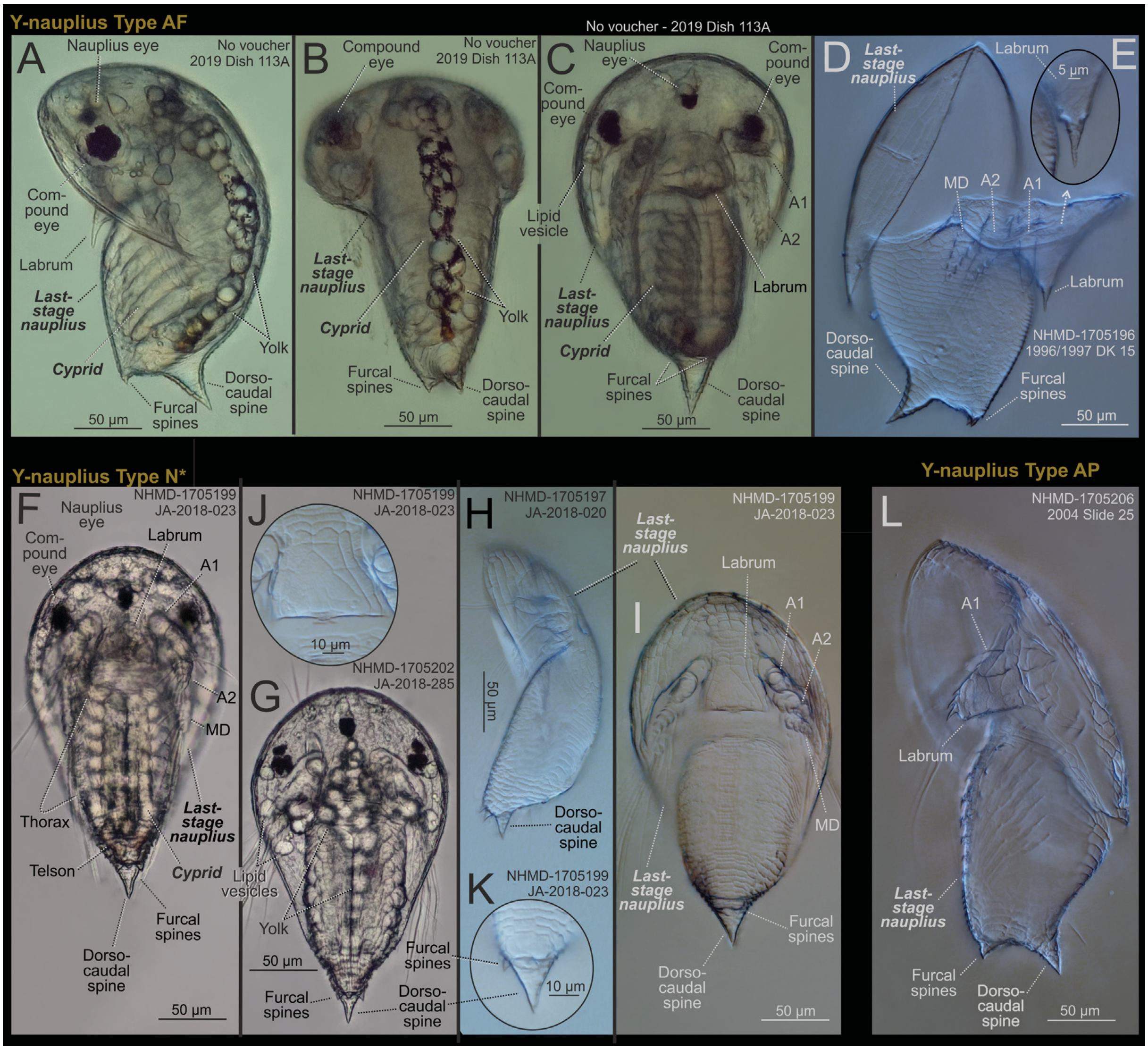

Fig. 17. Last-stage nauplii of three different morphospecies of y-larvae (Facetotecta) from Sesoko Island (Okinawa, Japan). **A–E**. Y-nauplius Type AF. **F–K**. Y-nauplius Type N*. **L**. Y-nauplius Type AP. Shown either in life (A–C, F–G) or as slide-mounted exuviae (D–E, H–L). Abbreviations: A1 = first antenna; A2 = second antenna; Md = mandible. L from Grygier *et al.* (2019).

Identification and variation

Recognizable by its protruding labrum with three spines. This morphospecies resembles Type AF but is larger, slightly less stout and has a differently armed labrum (three spines instead of a single needle-like extension).

Distribution

Japan (Sesoko Island, Okinawa).

Y-nauplius **Type AL**

Figs 2, 18A–F

Material examined

JAPAN – **Okinawa, Sesoko I., laboratory pier, 26°38′09.4″ N, 127°51′55.2″ E** • 3 LSN, 1 of which molted to cyprid; 2018–2019 (Tables 1 and S1).

Description

Last-stage nauplius (LSN). Lecithotrophic. Body narrowly ovate in dorso-ventral view; about 1.9 times as long as wide; relative length of trunk region quite variable; lateral margins with very slight narrowing in body outline between cephalic shield and trunk. In lateral view, longitudinal axes of cephalon and trunk in approximately same plane (not examined). Length 340 µm (ventral view in life, without dorso-caudal spine), greatest width ca 180 µm, dorso-ventral thickness not measured but body perhaps significantly flattened. Labrum produced as triangular elevation, about as long as wide, with surface divided into facets by cuticular ridges and bearing at least four pores: two in posterior midline and additional pair of pores rather posteriorly along left and right labral margins. Caudal end broadly acute, terminating in 10 µm long dorso-caudal spine with one or two annulate ridges, this spine being flanked ventro-laterally by pair of tiny, pointed furcal spines, these being situated slightly ventral to, and forward from, base of dorso-caudal spine.

Cyprid viewed through cuticle of LSN. Body pigmentation varying among examined specimens: one dark brown overall except in marginal areas, and telson with distinct, reddish-brown pigmentation; in another, only telson brown. Telson about as long as wide and half as long as thorax.

Identification and variation

Easy recognizable by its narrow-ovate form, dorso-ventrally flattened appearance and tiny furcal spines. Some variation was seen in the size of the furcal and dorso-caudal spines and in the pigmentation of the cyprid inside the LSN (see above).

Distribution

Japan (Sesoko Island, Okinawa).

Y-nauplius **Type AJ**

Figs 2, 18G–J

Last-stage lecithotrophic y-nauplius of an undescribed species – Dreyer *et al.* 2023b: 87–88, 90, 94, fig. 6.

Material examined

JAPAN – **Okinawa, Sesoko I., laboratory pier, 26°38′09.4″ N, 127°51′55.2″ E** • 4 LSN; 2018–2019 (Tables 1 and S1).

Description

Last-stage nauplius (LSN). Lecithotrophic. Body spoon- or ladle-shaped in dorso-ventral view; about 1.6 times as long as wide; cephalic shield widely ovate, with weak but distinct discontinuity in body outline leading into trunk; lateral margins of trunk tapering towards truncate caudal end bearing large dorso-caudal spine with base half as wide as posterior end of trunk. In lateral view, trunk axis

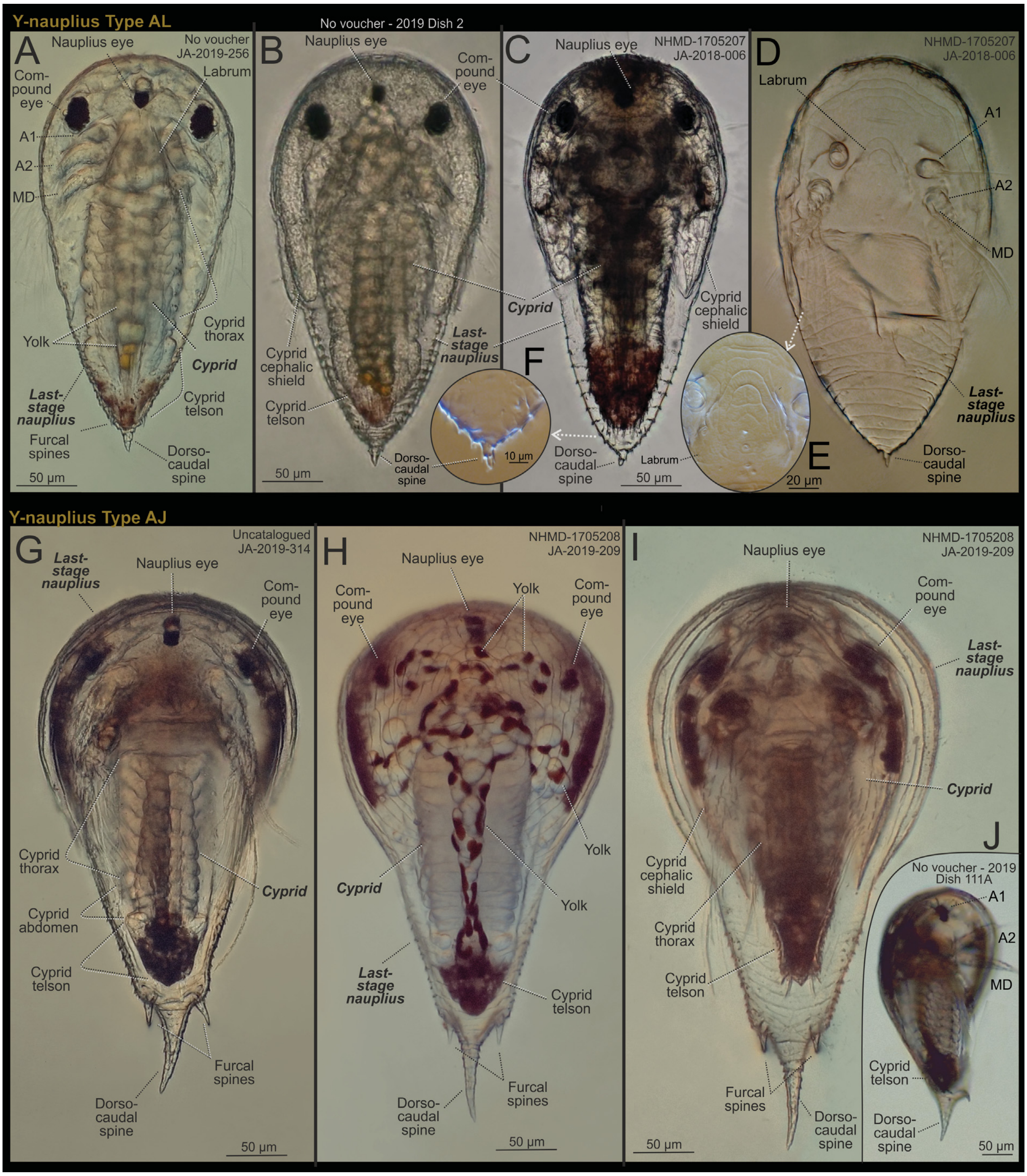

Fig. 18. Last-stage nauplii of two different morphospecies of y-larvae (Facetotecta) from Sesoko Island (Okinawa, Japan). **A–F**. Y-nauplius Type AL. **G–J**. Y-nauplius Type AJ. Shown either in life (A–C, G–J) or as slide-mounted exuviae (D–F). Abbreviations: A1 = first antenna; A2 = second antenna; Md = mandible.

downturned ca 50° with respect to cephalic axis. Length ca 350 µm (without dorso-caudal spine), greatest width ca 230 µm, greatest dorso-ventral thickness ca 130 µm. Labrum not examined in detail but apparently produced as trapezoidal elevation; surface structures not examined. Dorso-caudal spine ca 80 µm long, upturned ca 10–15° with respect to trunk axis, flanked ventro-laterally by pair of curved, postero-ventrally directed furcal spines 15–20 µm long.

Cyprid viewed through cuticle of LSN. Body overall weakly brownish but with lateral margins of cephalon and terminal part of telson distinctly darker brown. In earlier phase of LSN, gut-like tube as well as paired lateral diverticula in cephalon packed with brown and clear yolk granules in more or less symmetrical pattern. Telson about as long as wide and less than half as long as thorax.

Identification and variation

Easily recognizable by its general body form and distinctive brown and white coloration. Little variation is seen among specimens except in color pattern, differences possibly being attributable to the degree of development.

Distribution

Japan (Sesoko Island, Okinawa).

Y-nauplius **Type AK**

Figs 2, 19A–E

Material examined

JAPAN – **Okinawa, Sesoko I., laboratory pier, 26°38′09.4″ N, 127°51′55.2″ E** • 1 LSN; 1991–2005 • 4 LSN, 1 of which molted to a cyprid; 2018–2019 (Tables 1 and S1).

Description

Last-stage nauplius (LSN). Lecithotrophic. Body narrowly ovate in dorso-ventral view; about 1.7 times as long as wide; lateral margins tapering gradually towards caudal end with very slight discontinuity at posterior end of cephalic shield**.** In lateral view, trunk axis downturned 35–40° with respect to cephalic axis. Length 330–350 µm (without dorso-caudal spine), greatest width ca 200 µm, greatest dorso-ventral thickness ca 100 µm. Labrum weakly produced as bell-shaped elevation; not clearly divided into facets; pores not examined in detail but at least three present, one in posterior midline and one pair in postero-lateral corners. Caudal end rounded, terminating in three almost identical, 20 µm long, narrow-conical, pointed caudal spines; among them, ventro-laterally situated furcal spines narrower at base than dorsal-caudal spine.

Cyprid viewed through cuticle of LSN. Body overall weakly brownish, but terminal part of telson with distinct dark-brown pigmentation. Gut-like central tube in telson containing orange yolk granules. Telson about as long as wide, less than half as long as thorax.

Identification and variation

Easily recognizable by its general body form, especially the three equally long, thin caudal spines, and the brown pigmentation of the cyprid's telson. Variation among specimens was insignificant but few specimens were examined.

Distribution

Japan (Sesoko Island, Okinawa).

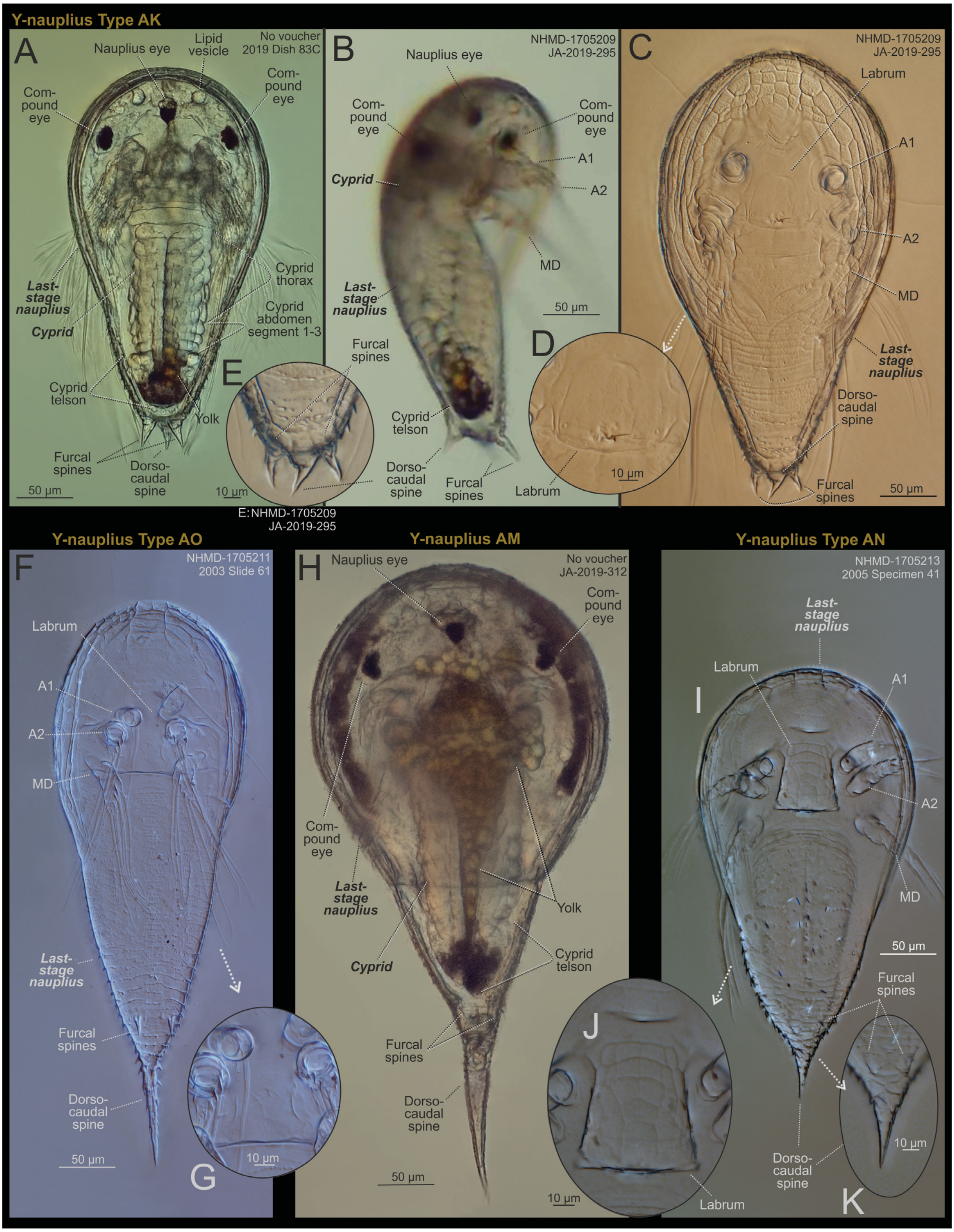

Fig. 19. Last-stage nauplii of four different morphospecies of y-larvae (Facetotecta) from Sesoko Island (Okinawa, Japan). **A–E**. Y-nauplius Type AK. **F–G**. Y-nauplius Type AO. **H**. Y-nauplius Type AM. **I–K**. Y-nauplius Type AN. Shown either in life (A–B, H) or as slide-mounted exuviae (C–G, I–K). Abbreviations: A1 = first antenna; A2 = second antenna; Md = mandible.

Y-nauplius **Type AO**

Figs 2, 19F–G

Material examined

JAPAN – **Okinawa, Sesoko I., laboratory pier, 26°38′09.4″ N, 127°51′55.2″ E** • 1 LSN; 1991–2005 (Tables 1 and S1).

Description

Last-stage nauplius (LSN). Lecithotrophic. Body shape lanceolate in dorso-ventral view; about 2.2 times as long as wide; lateral margins tapering gradually towards caudal end, with very slight narrowing apparent at posterior end of cephalic shield. No lateral view obtained, but longitudinal axes of cephalon, trunk and dorso-caudal spine apparently in nearly same plane. Length 366 µm (based on exuvia on slide, without dorso-caudal spine), greatest width 170 µm, greatest dorso-ventral thickness unknown but body apparently rather flattened. Labrum not examined in detail but with straight posterior margin and with surface undivided into facets; pores not examined. Caudal end attenuate, terminating in 90 µm long, spinose dorso-caudal spine accompanied by slightly more ventrally and forward-positioned pair of ca 17 µm long furcal spines.

Cyprid viewed through cuticle of LSN. The only available information on live specimens is from the slide label, which reports that the tip of the [cyprid] tail is brown.

Identification and variation

Recognizable by its great length relative to width, relatively long and slender dorso-caudal spine and relatively long furcal spines.

Distribution

Japan (Sesoko Island, Okinawa).

Y-nauplius **Type AM**

Figs 2, 19H

Material examined

JAPAN – **Okinawa, Sesoko I., laboratory pier, 26°38′09.4″ N, 127°51′55.2″ E** • 1 LSN; 2018–2019 (Tables 1 and S1).

Description

Last-stage nauplius (LSN). Lecithotrophic. Body lollipop-shaped in dorso-ventral view; about 1.6 times as long as wide; cephalic shield large and circular, with sharp discontinuity in body outline leading into trunk. In lateral view, longitudinal axes of cephalon, trunk and dorso-caudal spine in approximately same plane. Length 420 µm (without dorso-caudal spine), greatest width ca 260 µm, dorso-ventral thickness not measured but body apparently quite flattened. Labrum not examined in detail. Caudal end attenuate, terminating in ca 160 µm long, smooth dorso-caudal spine flanked ventrally at base by pair of small, thorn-like furcal spines ca 20 µm long.

Cyprid viewed through cuticle of LSN. Body overall weakly brownish but with lateral margins of cephalon and terminal part of telson distinctly darker brown. Gut-like tube packed with yellow yolk granules, these being markedly concentrated in central part of cephalon. Telson about as long as wide and less than half as long as thorax.

Identification and variation

Easily recognizable by its general form, especially the large rounded cephalic shield and very long, smooth dorso-caudal spine, and by the cyprid’s distinct pattern of brown pigmentation. Only one specimen was available, so variation could not be checked.

Distribution

Japan (Sesoko Island, Okinawa); Taiwan (Green Island) (unpublished).

Y-nauplius **Type AN**

Figs 2, 19I–K

Material examined

JAPAN – **Okinawa, Sesoko I., laboratory pier, 26°38′09.4″ N, 127°51′55.2″ E** • 4 LSN; 1991–2005 (Tables 1 and S1).

Description

LAST-STAGE NAUPLIUS (LSN). Lecithotrophic. Body narrowly ovate in dorso-ventral view; about 1.7 times as long as wide; lateral margins tapering gradually towards caudal end with slight discontinuity at posterior end of cephalic shield**.** No lateral view available, but longitudinal axes of cephalon, trunk and dorso-caudal spine apparently nearly in same plane. Length 320–350 µm (ventral view of mounted exuviae, without dorso-caudal spine), greatest width ca 190 µm, greatest dorso-ventral thickness unknown but body apparently rather flattened. Labrum produced as trapezoidal elevation divided into facets by cuticular ridges; pores not examined in detail. Trunk with rows of 5 µm long spines along margins. Caudal end attenuate, terminating in ca 50 µm long dorso-caudal spine accompanied ventrally and farther forwards by pair of triangular, pointed furcal spines ca 5 µm long. Dorso-caudal spine broad-based but sharply pointed, with irregularly ridged proximal portion bearing a few spinules.

CYPRID VIEWED THROUGH CUTICLE OF LSN. No live specimens studied.

Identification and variation

Recognizable by its general shape and by its significantly smaller size compared to the otherwise similar Type Y (see above).

Distribution

Japan (Sesoko Island, Okinawa).

Key to lecithotrophic last-stage y-nauplii

An identification key has been constructed for the 34 lecithotrophic naupliar morphospecies of facetotectans described herein from Sesoko Island, Okinawa, Japan. This key is designed for last-stage y-nauplii (LSNs). Primarily making use of external (cuticular) morphology, it is supplemented with information on coloration of the cyprid developing within when such data are helpful. Before identification can take place, it is necessary first to distinguish y-nauplii from the marine planktonic nauplii of other crustaceans, something that is actually very simple even without reference to the characteristic reticulation of the cephalic shield, as is done in the first couplet of two recent keys to crustacean nauplii (Dahms *et al.* 2006; Martin *et al.* 2014b). Y-nauplii differ from all cirriped nauplii in lacking fronto-lateral horns. They differ from also-hornless copepod and ascothoracidan nauplii in lacking furcal setae and in having a long, exposed trunk dorsum, respectively. The metanauplii differ from those of copepods, euphausiaceans and dendrobranchiate shrimp in never displaying thoracopodal limb-buds. After it has been established that the freshly-caught nauplii at hand are y-nauplii, the first question in the key deals with their feeding status. If the nauplius is planktotrophic (Figs 1C, 2C, 4), further identification using this key is not possible. The nine or so tentatively recognized planktotrophic y-naupliar morphospecies from Sesoko Island are not included in the key as their LSNs have not been recognized, but habitus photographs of them (Fig. 2), as well as detailed illustrations of one very common planktotrophic morphospecies (Type A*; Figs 1C, 4), are provided to help users through the first couplet.

If the y-nauplius is lecithotrophic, the next step is to determine whether it is a last-stage nauplius—easily recognizable by the presence of three eyes anteriorly (one nauplius eye and the developing cyprid's two compound eyes)—in which case use of the key can proceed. However, if the sampled y-nauplius is at an earlier stage of development, as was the case for more than 90% of the live-sampled lecithotrophic y-nauplii in 2018/2019 (Olesen *et al.* 2022) (Fig. 1A–B), then identification can proceed after the naupliar specimen has been reared to its last naupliar stage following procedures described above and elsewhere (Olesen *et al.* 2022). This may take up to ca 10 days depending on morphospecies. If the nauplius under study is at an earlier stage of development, the key may still be used if the nauplius has a particularly distinctive body shape, labral form or caudal-spine array, but the extent of this potential utility is as yet untested. Since the key is based mainly on external morphology, it should be applicable to preserved nauplii if these are LSNs. Once a nauplius has been tentatively identified to a particular morphospecies using this key, additional confirmatory information about living specimens, such as their coloration, should be checked in the respective descriptions and figures. It is likely, of course, that lecithotrophic nauplii will be found that fail to match any morphospecies in this key, especially in samples taken from distant locations and different habitats. Since this manuscript was written, we have found a few additional lecithotrophic morphospecies even at Sesoko Island (unpublished data from October 2023).

1. Second antennae and mandibles with feeding spines (either weakly or well developed); body with ovoid outline in dorsal view and dorso-ventrally flattened; trunk with rows of distinct postero-lateral spines (except Types J and S; Figs 1C, 2C, 4) ....Planktotrophic y-nauplius (further identification not possible here but see Fig. 2C)
– Second antennae and mandibles without feeding spines; with yolk present internally and therefore often swollen; body generally lacking distinct postero-lateral spines (except Types U* and V; Fig. 12) ....2, Lecithotrophic y-nauplius (Note: if not already an LSN (with three anterior eyes), the nauplius must be reared to this stage to proceed further)

2. Dorso-caudal spine >3 times as long as basal width 3
– Dorso-caudal spine shorter than this, or low-conical 21

3. Labral midline with keel bearing row of at least 3 spines; keel sometimes much extended ventrally or posteriorly 4
– Labral midline with no row of spines 6

4. Labrum extended ventrally into huge crest-like extension with apical row of spines ....***Hansenocaris cristalabri*** Olesen & Grygier, 2022 (Fig. 9A–C)
– Labrum with midline spines in simple row 5

5. Trunk with 4 distinct dorsal rows of spines; body about 400 µm long excluding dorso-caudal spine ....***Hansenocaris aquila*** Olesen & Grygier, 2022 (Fig. 9D–E)
– Trunk lacking any dorsal rows of spines; body about 270 µm long excluding dorso-caudal spine ....Y-nauplius **Type AC** (Fig. 9F–H)

6. Labrum with median spine on posterior margin 7
– Labrum with no median spine on posterior margin 11

7. Dorso-caudal spine relatively short (ca ⅛ of body length) ....Y-nauplius **Type AD** (Fig. 11H–M)
– Dorso-caudal spine relatively long (>⅙ of body length) 8

8. Labrum with rounded-quadrangular outline with nearly parallel lateral margins ....Y-nauplius **Type AG*** (Fig. 10G–K)
– Labrum with differently shaped outline 9

9. Labrum lacking free, rounded posterior margin; labral outline pentagonal ....Y-nauplius **Type E*** (Fig. 10A–F)
– Labrum with free, rounded posterior margin; labral outline not pentagonal 10

10. Posterior margin of labrum extended as median spine; keel absent on labral midline ....Y-nauplius **Type AH*** (Fig. 9I–N)
– Posterior margin of labrum not extended as median spine; distinct keel present on labral midline ....Y-nauplius **Type W** (Fig. 11A–G)

11. Furcal spines ca 3 times as long as wide, curved 12
– Furcal spines shorter or vestigial 13

12. Cephalic shield much wider than half body length; with weak but distinct discontinuity in body outline at posterior end of cephalic shield leading into trunk ....Y-nauplius **Type AJ** (Fig. 11G–J)
– Cephalic shield about half as wide as body length; lateral body margins tapering gradually in ventral view, with no interruption at posterior end of cephalic shield ....Y-nauplius **Type D*** (Fig. 7A–G)

13. Furcal spines present as double-spines ....Y-nauplius **Type AI** (Fig. 14G–L)
– Furcal spines present as single spines or vestigial 14

14. Body ca 1.3 times as long as wide ....Y-nauplius **Type U***
– Body ≥5 times as long as wide 15

15. Dorso-caudal spine with broad base, almost continuous with lateral margins of caudal end of body ....Y-nauplius **Type X** (Fig. 13A–E)
– Dorso-caudal spine with narrower basis, less continuous with lateral margins of caudal end of body 16

16. Cephalic shield large, rounded and set off from rest of body ....Y-nauplius **Type AM** (Fig. 19H)
– Cephalic shield otherwise 17

17. Body ca 2.5 times as long as wide ....Y-nauplius **Type AO** (Fig. 19F–G)
– Body ≤2 times as long as wide 18

18. Labrum produced as sub-triangular elevation 19
– Labrum produced as sub-quadrangular elevation 20

19. Cyprid (within last-stage nauplius) completely brown ....Y-nauplius **Type L** (Fig. 15A–F)
– Cyprid (within last-stage nauplius) only with brown telson ....Y-nauplius **Type M** (Fig. 14A–F)

20. Length of body 320–350 µm; lateral margins of body with slight discontinuity at posterior end of cephalic shield in dorsal view; dorso-caudal spine 2–3 times as long as its basal width .... Y-nauplius **Type AN** (Fig. 19I–K)
– Length of body 360–400 µm; lateral margins of body tapering gradually in dorsal view, without discontinuity at posterior end of cephalic shield; dorso-caudal spine 4–5 times as long as its basal width .... Y-nauplius **Type Y** (Fig. 16A–E)

21. Body significantly bent, angle between longitudinal axes of cephalic shield and trunk >45° ...22
– Body not significantly bent, angle between longitudinal axes of cephalic shield and trunk <40° ...30

22. Furcal spines >3 times as long as basal width and curved 23
– Furcal spines approximately equal in length to basal width and uncurved 26

23. Dorso-caudal spine placed relatively far dorsally, not conical ......Y-nauplius **Type B** (Fig. 7H–M)
– Dorso-caudal spine not placed particularly far dorsally, conical 24

24. Furcal spines shorter than width of caudal region, trunk axis downturned much less than 90° with respect to cephalic axis ....Y-nauplius **Type F** (Fig. 8A–D)
– Furcal spines longer than width of caudal region, trunk axis downturned ca 90° with respect to cephalic axis 25

25. Furcal spines ca 5 times as long as basal width, each with 1 small subsidiary spine at base; dorso-caudal spine conical, robust ....Y-nauplius **Type H** (Fig. 8H–J)
– Furcal spines ca 3 times as long as basal width, each with 2 small subsidiary spines at base; dorso-caudal spine conical, small ....Y-nauplius **Type G** (Fig. 8E–G)

26. Dorso-caudal spine not conical, instead thin and small ......Y-nauplius **Type K** (Figs 5D–F, 13F–J)
– Dorso-caudal spine conical, sometimes very short 27

27. Conical dorso-caudal spine very short, about as long as basal width .... Y-nauplius **Type AB** (Fig. 15G–M)
– Conical dorso-caudal spine 2–3 times as long as basal width 28

28. Labrum without spine(s); furcal spines closely adjacent to base of dorso-caudal spine .... Y-nauplius **Type N*** (Fig. 17F–K)
– Labrum with spine(s); furcal spines distant from base of dorso-caudal spine 29

29. Labrum extending into needle-like spine ....Y-nauplius **Type AF** (Fig. 17A–E)
– Labrum bearing row of 3 large spines ....Y-nauplius **Type AP** (Fig. 17L)

30. Body length ca 3 times its width ....***Hansenocaris demodex*** Olesen *et al.*, 2022 (Figs 5A–B, 6A–F)
– Body length ca 2 times its width 31

31. Caudal end of body lined laterally with rows of distinct spines ....Y-nauplius **Type V** (Fig. 12E–G)
– Caudal end of body lacking any such rows of distinct spines 32

32. Caudal spines all of about same length 33
– Caudal spines unequal in length 34

33. Caudal spines ca 3 times as long as wide ....Y-nauplius **Type AK** (Fig. 19A–E)
– Caudal spines about as long as wide ....Y-nauplius **Type C** (Fig. 6G–L)

34. Body sub-ovoidal ....Y-nauplius **Type AL** (Fig. 18A–F)
– Body sub-triangular ....Y-nauplius **Type O*** (Fig. 16F–J)

Relative abundance and constancy of LSN morphospecies of Facetotecta at Sesoko Island in 2018 and 2019

Because the youngest and most common naupliar stages caught in plankton frequently cannot be directly tied to the corresponding LSN and cyprid stages, direct assessments of the relative abundance of different y-larval morphospecies in plankton samples, based on all naupliar stages present, cannot be done. In consequence, the following results concerning relative abundance are based solely on the 420 lecithotrophic individuals that were reared to their LSN and videographed at Sesoko Island in 2018/2019.

The relative abundance of lecithotrophic morphospecies (LSN ‘Types’ and cyprids) is presented visually in a bar chart (Fig. 20). A weak negative correlation (-0.35075) was found between the number of last-stage nauplii and their size (Table 1; cf. the same-scale photos of all morphospecies in Fig. 20). Since only about 8% of reared individuals survived to the LSN stage and the identity of the failed individuals was largely unknown and not recorded, the proportions of morphospecies among these LSNs may be different from their proportions in the plankton. Nonetheless, overall, the relative abundance of different y-naupliar forms followed the same pattern in 2018 and 2019 (Table 1), with 22 of 30 morphospecies (73%) occurring in both years. The nine most abundant morphospecies overall (Types O*, E*, C, D*, AH*, AG*, K, G, N*) were, with a few exceptions, the most common ones in both years. Notable exceptions were Type K (only one specimen in 2019) and Types G and N* (few specimens in 2018 and 2019, respectively). Conversely, the same set of low-abundance morphospecies was found in both years. There was a smaller overlap in occurrence between 2018/2019 and the earlier more sporadic collections from 1991 to 2005, involving only 18 of the total of 34 morphospecies (53%).

Discussion

Lecithotrophic y-nauplii from Okinawa – how many kinds?

Evidence of a large, unexplored diversity of facetotectan larvae in shallow marine plankton at certain Japanese localities has long been available (Itô 1990a, 1990b; Grygier 1991; Glenner *et al.* 2008; Grygier *et al.* 2019; Olesen *et al.* 2022). Recently, molecular evidence has suggested the existence of about 100 species at the present inshore coral-reef site at Sesoko Island (Okinawa) (Dreyer *et al.* 2023a). Among the 160 sequenced specimens from there, only one named form, *Hansenocaris demodex*, could be identified. The remainder were treated as ‘y-naupliar morphospecies’ or ‘types’ with very little morphological description, not enough for formal species descriptions or even proper identification to morphospecies. Both planktotrophic and lecithotrophic morphospecies were present. The latter were most diverse and are the focus of the present work, in which 34 lecithotrophic y-naupliar morphospecies are illustrated and described, including 23 that were included in Dreyer *et al.*’s phylogeny (Dreyer *et al.* 2023a) and 11 additional types.

The 34 morphospecies described here appear to represent a significant fraction of the total diversity of lecithotrophic y-nauplii present in the plankton at Sesoko Island. Evidence of this is seen in the significant overlap in naupliar types (24 out of 30, 80%) between two independent three-week long sampling programs undertaken in two different seasons (autumn of 2018, late spring of 2019; see Table 1). Comparison to material from earlier fieldwork (90 more sporadically collected specimens) also revealed a large overlap in naupliar types (19 out of 34, 56%) (Table 1). Nevertheless, the complete y-larval diversity at Sesoko Island is most likely still not fully recognized, as sampling has been too scattered to ensure full data saturation. Some morphospecies were found in very small numbers (e.g., single specimens of *Hansenocaris cristalabri* and Types AO, AP), and more rare forms are likely to show up with additional sampling. In October 2023, a new sampling program did indeed turn up small numbers of at least seven previously unrecognized morphospecies that cannot be treated here. When molecularly detected diversity within certain lecithotrophic morphospecies (those with an asterisk attached to their designation, e.g., Types D*, E*, AH*) is taken into account (Dreyer *et al.* 2023a), the final species number of Okinawan y-larvae with lecithotrophic nauplii may end up being markedly higher than 34. This still does not take the planktotrophic naupliar morphospecies into account. Illustrations of nine of these are presented herein (Figs 1C, 2C, 4), but molecular and morphological diversity within Types A* and I* suggest that they are polytypic (Dreyer *et al.* 2023a).

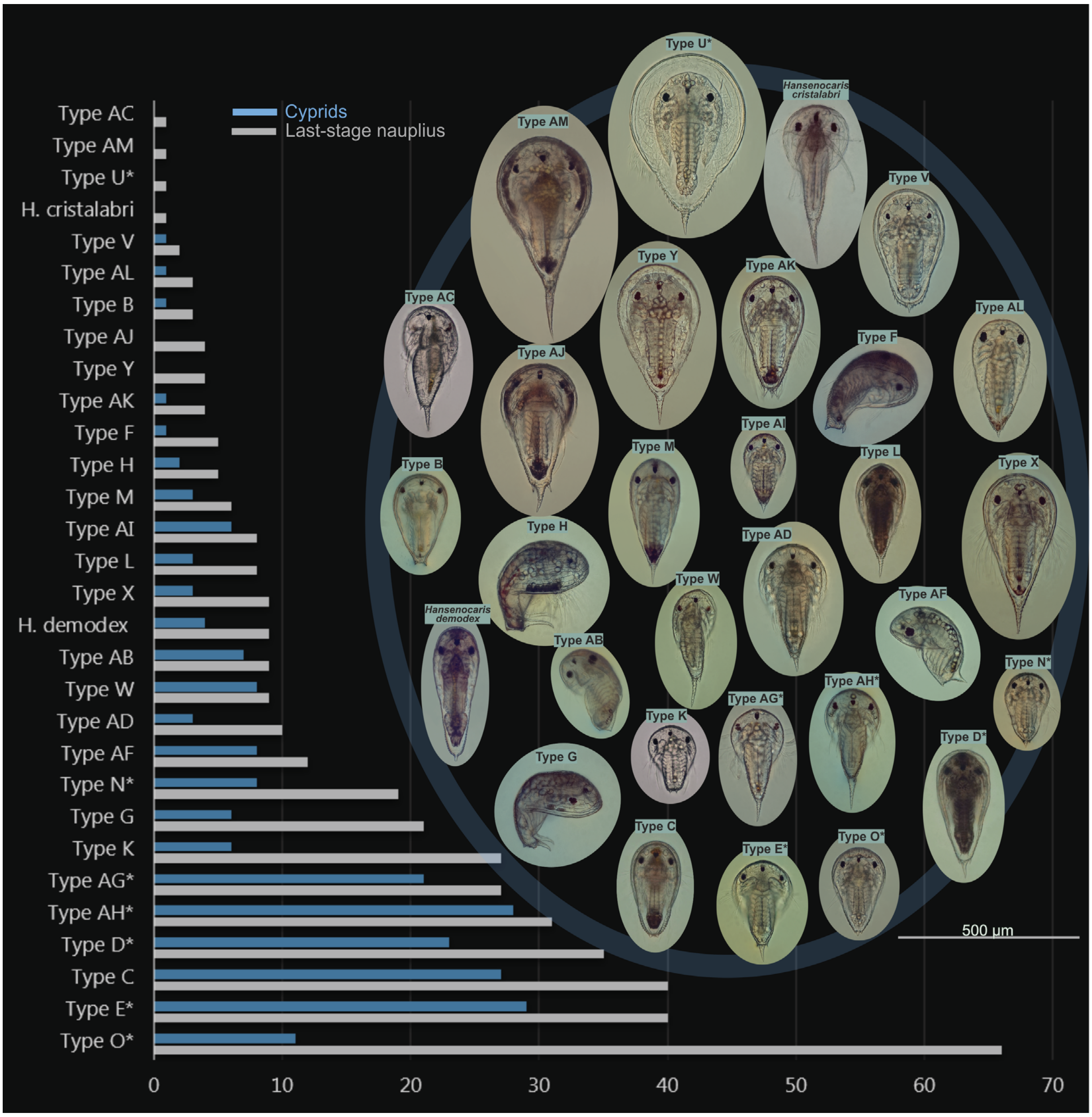

Fig. 20. Relative abundance of lecithotrophic y-nauplii at Sesoko Island (Okinawa, Japan) during field work in 2018 and 2019. Grey bars denote the number of lecithotrophic nauplii of each morphospecies that survived until the last naupliar stage during laboratory rearing. Blue bars show the numbers of cyprids that successfully molted from these last-stage nauplii. Images of all lecithotrophic y-naupliar morphospecies obtained during those two years are shown to the same scale.

There is now overwhelming evidence, both morphological and molecular, that the earlier estimate of at least 40 species of y-larvae in the marine shallow-water plankton at Sesoko Island (Glenner *et al.* 2008) was not wildly off the mark. Other sites where y-larvae have been caught in large number exist in various places around the world (Dreyer *et al.* 2023b), but so far none with such a high degree of species-level diversity as is now documented at Sesoko Island.

Eventually, after time-consuming examination of multiple specimens of assuredly conspecific nauplii and cyprids that have been linked by rearing and/or molecular methods, at least all the lecithotrophic forms should be described and named formally. The present publication will serve as a stopgap while this work proceeds, thereby providing some needed publicity for this overlooked but locally common taxon of shallow-water marine crustacean plankton.

Morphological diversity of y-nauplii – implications for phylogeny within Facetotecta

As shown herein, Facetotecta encompasses a remarkable phenotypic diversity of nauplii, ranging from short, compact forms (e.g., Type K), sometimes with a 90° body bend (e.g., Types F and G), to long, attenuate (e.g., Type AM) or large, somewhat disc-shaped forms (e.g., Types U* and Y). Tremendous variation is seen in the outline, prominence, spinal armature and reticulation of the labrum; in the length, orientation and subsidiary armature of the three caudal spines; and also in the coloration of yolk and other internal structures in live specimens. The y-naupliar diversity is almost endless. Dreyer *et al.* (2023a) recognized five or six major clades in their material. Difficulty in specifying morphological naupliar synapomorphies for any of these clades was attributed to each clade’s (with one exception) inclusion of both conservative/plesiomorphic planktotrophic y-nauplii and more derived lecithotrophic y-nauplii. Here, however, a significant amount of new morphological detail has been presented for 34 morphospecies of lecithotrophic y-nauplii, 23 of which had been included in the above-mentioned molecular phylogenetic analysis (Dreyer *et al.* 2023a). This provides an opportunity to re-address the possible support in naupliar morphology for the various molecular clades. As recounted in the following sections, support does exist for many smaller lecithotrophic clades, along with what appear to be striking examples of convergent evolution.

Itô’s (1991) y-nauplius—an abundant spoon-shaped naupliar form

Practically none of the 34 lecithotrophic y-naupliar types/species described here or treated by Dreyer *et al.* (2023a) were mentioned in pre-2022 literature. An important exception is a naupliar type with a characteristic shape from Tanabe Bay, Honshu, Japan, that was illustrated and referred to as ‘*Hansenocaris* sp.’ by Itô (1991). This is a relatively compact, spoon-shaped y-naupliar type with a long dorso-caudal spine, small furcal spines, a spinose labrum, a distinctly downturned trunk with a swollen ‘belly’, and, in ventral view, a rounded cephalic shield that is clearly demarcated from the posteriorly attenuate trunk. In the initial phases of the present project, when starting to sort the enormous material of y-nauplii, it became clear that Itô’s (1991) form might correspond to any of several of the Okinawan forms encountered. Due to their small size and the incomplete nature of Itô’s drawings, it was long unclear which was the best match. About 25% of all lecithotrophic y-nauplii collected at Sesoko Island, corresponding to six or seven separate morphospecies (Types E*, W, AC, AD, AG*, AI, AH*), were initially categorized as being similar to Itô’s (1991) *Hansenocaris* sp. Subsequently separated by the combination of labral morphology, caudal spine morphology etc., the distinctness of these putative species was later confirmed by molecular data (Dreyer *et al.* 2023a). Among these newly recognized types, Type E* (Fig. 10A–F) appears closest (likely conspecific) to Itô’s (1991) *‘Hansenocaris* sp.’

Unexpectedly, not all these relatively similar morphospecies grouped together in the phylogeny in Dreyer *et al.* (2023a), which raises interesting questions regarding the evolution of y-naupliar body morphology. The spoon-shaped Types AG* and AH* group together in the tree (Dreyer *et al.* 2023a) very far from the similarly spoon-shaped Types E* and AD, for example. Should this be explained as convergent evolution of this type of larval morphology or as shared retention of an older larval body form (symplesiomorphy)? Currently this is not completely clear. Could the spoon-shaped y-naupliar appearance seen in the mentioned types be ancestral for Facetotecta? The Cambrian *Bredocaris admirabilis* (Müller & Walossek 1988; Walossek & Müller 1998), a Cambrian micro-crustacean purportedly on the stem lineage of Thecostraca (see also Wolfe & Hegna 2014), bears some resemblance to these spoon-shaped y-naupliar types. Dreyer *et al.* (2023a) came to the possibly more likely conclusion that the morphologically more complex planktotrophic y-nauplii (with well-developed feeding apparatus, e.g., Type A*, Fig. 4) are generally ancestral in Facetotecta evolution, and that lecithotrophic (non-feeding) y-nauplii (including the spoon-shaped types) have been derived multiple times, thereby displaying a remarkable level of convergent evolution.

Extreme 'body bending' in y-nauplii

The spoon-shaped forms are not the only y-naupliar types in which the body is bent. Indeed, in the majority of lecithotrophic y-nauplii, the trunk region is ventrally downturned to a varying degree relative to the cephalic shield (see examples in Fig. 5). The angle of the downturn is one of the important criteria used herein for categorizing and describing y-nauplii. This angle may be near-zero in morphospecies with an almost straight body, such as the large, disc- or racket-shaped types (e.g., Types U* and Y; Figs 12A–B, 16C and Olesen *et al.* 2024) or may reach as much as 90° (Types G and H; Fig. 8), but most types fall between these extremes. Mapping all sequenced specimens on the molecular phylogeny of Facetotecta shows that the degree of body bending has been plastic in y-naupliar evolution and that much convergence has occurred (Dreyer *et al.* 2023a). All the planktotrophic y-naupliar morphospecies introduced here are relatively straight-bodied in lateral view (e.g., Type A* is 15% downturned, Fig. 4B), which may well be the plesiomorphic condition from which naupliar body bending has arisen multiple times.

We especially wish to draw attention to the three apparently closely related lecithotrophic Types F, G and H (the 'bird-talon' morphospecies; Fig. 8), which are nested phylogenetically within a large, diverse clade of otherwise planktotrophic nauplii (Dreyer *et al.* 2023a). They display a stepwise progression of gradually more extreme naupliar morphology. In Type F (Fig. 8A–D) the body is only moderately bent, the furcal claws are relatively small and hook-like and the conical dorso-caudal spine is relatively prominent. In contrast, in Types G and H (Fig. 8E–J) the trunk is downturned at a right angle, the furcal claws (again turned 90° relative to the trunk, but thereby extending anteriorly, parallel to the cephalic axis) are very large and talon-like (longer in Type H) and the dorso-caudal spine is much reduced. Their swimming seems hampered, and their hydrodynamics may be as challenged as it is for the UFO-shaped nauplii of laevicaudatan branchiopods (Olesen 2005) and the 'flying saucer larvae' (among others) of certain stomatopods (Haug *et al.* 2016). Ad hoc explanations for extreme larval body shape often involve hypotheses of 'increase in buoyancy' or 'defense'; such may apply to these odd y-nauplii, too, but experimental evidence is lacking.

Large disc- and racket-shaped y-nauplii

Among the most charismatic of the lecithotrophic y-nauplii are several kinds with large, dorso-ventrally flattened, disc- or racket-shaped bodies. The large number of specimens available in the present study allowed four different morphospecies with such morphology to be recognized (Types U*, V, X, Y; Figs 12, 13A–E, 16A–E). In coastal waters of mainland Japan, three types of disc-shaped y-nauplii, termed Types VIII-a to VIII-c, were described from Tanabe Bay (Itô 1987b); Types VIII-a, VIII-b, and unspecified Type VIII have also been recorded from Manazuru in Sagami Bay (Kikuchi *et al.* 1991; Watanabe *et al.* 2000). Among the present morphospecies, they are probably most similar to Type U* but differ from it in having a pair of distinct antero-lateral indentations in the margin of the cephalic shield. In Dreyer *et al.*'s (2023a) recent phylogeny of Facetotecta, the present four disc- or racket-shaped morphospecies grouped together but were clustered with some planktotrophic morphospecies, to which they bear some physical resemblance. The similarities are not profound, but besides the general broadness of the discs and, in the case of nauplii of *H. itoi*, their large size, Types U*, V and Y share very reduced furcal spines with the planktotrophic nauplii of Types T*, Z* and *Hansenocaris itoi*. Furthermore, in all these forms, both lecithotrophic and planktotrophic, these small furcal spines are placed ventrally at some distance from the caudal end, quite different from other planktotrophs (e.g., Type A* in Fig. 4), in which the caudal spine is large and placed terminally. The ‘discs’ and ‘rackets’ are among the largest y-nauplii. Their size and shape may facilitate oceanic dispersal, as has been suggested as well for the similarly disc-shaped, but much larger, phyllosoma larvae of palinurid and scyllarid lobsters (Palero & Abelló 2007; González-Gordillo *et al.* 2017).

Diversity in labral morphology

Despite rarely being plate-like and overhanging the mouth opening as in planktotrophic y-nauplii, the labrum is a particularly distinct aspect of the body morphology of lecithotrophic y-nauplii. Labral form proved to be very useful during this study’s specimen-sorting process; many labral features were available irrespective of kind of specimen or study technique (mounted exuviae, videos of living specimens, whole specimens mounted for SEM). All 34 of the lecithotrophic y-naupliar morphospecies described herein have their characteristic labral shapes, ornamentation (pores, spines and patterns of cuticular ridges) and degree of projection from the ventral cephalic surface, practically like a ‘fingerprint’. Labral form and subsidiary spination of the dorso-caudal spine are the two main criteria for morphologically distinguishing the several above-mentioned spoon-shaped naupliar morphospecies that resemble Itô’s *Hansenocaris* sp. (Itô 1991). Labral morphology may indeed be species-specific among lecithotrophic facetotectan nauplii, with the caveat that some naupliar morphospecies may correspond to more than one molecularly distinguishable entity (Dreyer *et al.* 2023a).

The reason for the tremendous variation in labral morphology of these non-feeding nauplii is unclear. In some, any bulge representing the labrum is indistinct or missing (e.g., *Hansenocaris demodex* and Types C, U*, X and Y; Figs 6K, 12C, 13D, 16D), as might be expected for non-feeding nauplii and as is indeed found in different crustaceans (see Martin *et al.* 2014a). Many lecithotrophic y-naupliar morphospecies nonetheless have a distinct labrum, with at least a posterior declivity or even a short, slightly overhanging posterior lobe reminiscent of that seen ventrally bounding the oral cavity in planktotrophic nauplii (cf. *H. itoi*: Kolbasov *et al.* 2021b; Type A* nauplii: Fig. 4). It should not be forgotten that most of the described kinds of cypris y have a large, spiny labrum, which requires a precursor in the nauplius within which to form. Because Dreyer *et al.*’s (2023a) recent molecular phylogeny of Facetotecta showed intermixed placements of lecithotrophic and planktotrophic morphospecies, implying multiple origins of lecithotrophy, we consider it likely that the distinctly formed labra of many lecithotrophic y-nauplii are derived from labra with a feeding function in their planktotrophic ancestors. Their main function now may be to house the developing y-cyprid’s labrum.

The presence of one or more labral spines in many lecithotrophic morphospecies of y-nauplii suggests another function, details of which are unclear. Most commonly in such forms, the labrum is extended into a small or medium-long postero-median spine (e.g., Types AH*, E*, AG* and AD; see Figs 9M, 10E, G, 11L), the form of which is to some degree ‘type’-specific. Other lecithotrophic y-nauplii exhibit extraordinary forms of labral spination. For example, two rather rotund, ‘blimp-like’ morphospecies (Types AF and AP; Fig. 17A–E, L) have a quite prominent labrum with, respectively, a median spine projecting posteriorly like a needle or a row of three large, blunt spines. *Hansenocaris aquila* has spine bearing median keel of the labrum that extends posteriorly like an eagle’s beak (Olesen & Grygier 2022; Olesen *et al.* 2024), and Type AC has a more robustly spiny labral keel and no jutting beak (Fig. 9F–H). *Hansenocaris cristalabri* has an extraordinary labral keel that is produced ventrally into an enormous spine-bearing crest of unclear function. Naupliar labral spines of a size comparable to those of some of these y-larval (morpho)species are otherwise found only in spinicaudatan larvae (Olesen & Grygier 2003, 2004, 2014), where again the function is uncertain.

In summary, labral morphology is enormously diverse among lecithotrophic y-nauplii and apparently characteristic for 'types'/species. It is currently impossible to explain this diversity in functional terms, not least since the nauplii involved are non-feeding.

Y-nauplii or y-cyprids—which is most useful for taxonomy?

In this paper, a morphologically very diverse assemblage of lecithotrophic y-nauplii collected at a single Okinawan locality is introduced. It has already been shown that much of this diversity in form can roughly be translated into 'species diversity' using molecular criteria of species delimitation (Olesen & Grygier 2022; Dreyer *et al.* 2023a), although fully detailed species-by-species descriptive work will be needed to determine exact species borders. The extent to which the diversity of y-naupliar morphospecies is matched by the diversity of y-cyprids is not clearly understood, as morphological study of the cyprids that correspond to the naupliar morphospecies described herein has barely begun. Studies, partly unpublished, of the cyprids of six (morpho)species, viz., *H. demodex* and Types C, D*, K, AH* and AG*, nevertheless show that they are all distinct and recognizable based on a combination of color pattern in life, body size and morphological details such as labral spination (cf. the cyprids of *H. demodex* and Type C: Olesen *et al.* 2022; Dreyer *et al.* 2023b). It is clear, though, that even preliminary discrimination of y-cyprid 'types' requires more detailed microscopic examination (preferably by SEM) than last-stage nauplii require (no SEM necessary). The subtleness of cyprid characters and the necessity of SEM for their study were recently demonstrated for a variety y-cyprids (Kolbasov *et al.* 2022). An attempt to delineate morphospecies and designate new 'types' based only on the reared cyprids in the present Okinawan material, as we have done herein for LSNs of lecithotrophic y-nauplii, would have been practically impossible, as it would require unfeasibly detailed SEM examination of > 500 cyprid specimens. While the cyprids will probably prove to be equally distinct as the LSNs, but at a finer level of detail, only nauplii can currently be sorted to morphospecies by eye during large-scale field studies. According to the protocol outlined by Olesen *et al.* (2022), detailed taxonomic work will nonetheless require SEM of both LSNs and lab-reared cyprids of each putative species in order to avoid parallel taxonomies of the two larval phases, and to provide a complete morphological underpinning for further cladistic study of the evolution of these larval crustaceans.

The crucial practical importance of y-naupliar morphology for diversity-oriented fieldwork and taxonomy of Facetotecta, as revealed herein, contrasts mightily with the central position y-cyprids have had in facetotectan taxonomy until now. The earliest studies, including the recognition of Types I to V by Hansen (1899) and the description of "*Proteolepas*" *hanseni* by Steuer (1904), were based on nauplii, but when formal taxonomic practice was reinitiated by Itô (1985), with his establishment of the genus *Hansenocaris* containing four species, it was based on cyprids. Since then, the cyprid has arguably been the most important life stage in facetotectan taxonomy, being either the basis of the description or being described after a nauplius-based original description. The cypris has been described for nine of the 17 named species (see Olesen *et al.* 2022; Olesen & Grygier 2022). The remaining species have been based on nauplii of different developmental stages (Steuer 1904; Belmonte 2005; Swathi & Mohan 2019; Olesen & Grygier 2022). Although it has been asserted that "The diversity of the Facetotecta is seen best in the y-cypris" (Kolbasov *et al.* 2022: 13), the present work demonstrates that the morphological diversity among lecithotrophic y-nauplii is exorbitant and that naupliar diversity can be more easily handled/sorted using standard light-microscopical methods than that of cyprids can. Therefore, when investigating the y-larva fauna at a site with a rich diversity of lecithotrophic nauplii, the best approach is unquestionably to turn the procedure 'upside down' and focus first on y-naupliar diversity (of LSNs) when establishing new taxonomic units, but yet still describe the conspecific cyprids produced by laboratory rearing and add barcode-type molecular data as advised here and elsewhere (Olesen & Grygier 2022; Dreyer *et al.* 2023a). As such, this represents a new paradigm in y-larval taxonomy.

Several questions remain regarding practical aspects of y-larva taxonomy. How should one treat the planktotrophic nauplii? At Sesoko Island, these are exemplified by seven to nine morphospecies (Fig. 2C), some of which have been shown by molecular data possibly to correspond to multiple genetic species (Dreyer *et al.* 2023a). Rearing is not feasible for most planktotrophs because very few molt in the lab—such molts have been observed only by Itô (1990a) and Kolbasov *et al.* (2021b) for *Hansenocaris furcifera* and *H. itoi*, respectively—or perhaps their developmental span is too long for simple lab rearing. This means that there is no easy way to obtain either LSNs or LSN-linked cyprids of the different kinds of planktotrophic y-nauplii. Given our recommendation that as a rule both nauplii and cyprids of y-larvae need to be described in order to avoid parallel taxonomies (Olesen *et al.* 2022), barcode-type molecular data will be needed to link planktotrophic nauplii of different stages to the corresponding cyprids. A variety of photo-vouchered planktotrophic nauplii (similar to the photos in Fig. 2C) is already available (Dreyer *et al.* 2023a), but they must not only be linked by barcodes to freely caught (non-reared) cyprids; a method must be developed to study the morphology of these cyprids following DNA extraction (work in progress). In the meantime, it appears that the several recently described species based on assorted planktotrophic y-nauplii from Italy and the Andaman Islands (Belmonte 2005; Swathi & Mohan 2019) will be of limited use going forward because of the lack of associated molecular data. It will certainly be challenging to link these species to other parts of their larval sequence, in particular to their cyprids. Such an approach, if followed on a global scale, would result in a myriad of y-larval nomina dubia.

What then about the species that are based solely on cyprids (Itô 1985, 1986b; Kolbasov *et al.* 2007, 2021a)? Although two such species, *Hansensocaris furcifera* and *H. itoi*, have been linked to corresponding conspecific nauplii (Itô 1990a; Kolbasov *et al.* 2021b), either by molting of cyprids from LSNs or by inference based on the supposed presence of a single species in the study region, such indicators will be unavailable for most of the planktotrophic y-nauplii. Without molecular data, it will be difficult to confirm the conspecificity of Ito's (1985, 1986b) four other cyprid-based species of *Hansenocaris* with any of the y-naupliar types covered herein, something that is conceivable because Itô's and our material is from the same zoogeographic region influenced by the Kuroshio Current. One hope might be that the anticipated detailed study of y-cyprids reared from many of the present naupliar morphospecies produces specimens that appear to match Itô's descriptions. The situation seems more hopeless for two other recently described cyprid-based species from Indonesia (Kolbasov *et al.* 2007) and the Azores (Kolbasov *et al.* 2021a), both of which were based on single individuals for which molecular data will never be available.

Relative abundances of y-naupliar morphospecies in coral-reef plankton at Sesoko Island

Fieldwork in 2018 and 2019, when almost 10 000 y-larval specimens were sampled, has reconfirmed that y-larvae are very abundant in Okinawan inshore coral-reef plankton, at least at Sesoko Island. Since this manuscript was written, renewed sampling has resulted in an additional ca 5000 y-larval specimens from Sesoko Island (unpublished data from October 2023). Dreyer *et al.* (2023b) provided an overview of the occurrence there of the three broad categories of y-larvae, namely planktotrophic y-nauplii, lecithotrophic y-nauplii, and y-cyprids, during the three-week survey period in 2019. Y-nauplii were significantly more common than y-cyprids, lecithotrophic nauplii more common than planktotrophic nauplii, and all three categories tended to be least abundant in the water column during midday (11:00–13:00). Despite certain difficulties that may make the present data unrepresentative (see the Methods section above), we have been able to provide supplementary information on the relative abundance of different kinds (morphospecies) of lecithotrophic y-nauplii at this site.

Different morphospecies were variously common or rare in our samples (Table 1, Fig. 20), but the profound similarities in their occurrence (80% overlap) and relative abundance during surveys conducted about seven months apart (autumn of 2018, late spring of 2019) suggest that the true faunal composition was well represented. Significant differences were also found, e.g., for Type K, the smallest morphospecies at the site, which occurred in large numbers in 2018 (26 specimens) but very rarely in 2019 (one specimen). It cannot be said whether such fluctuations are merely stochastic noise or reflect some fundamental aspect of facetotectan ecology. It has been suggested (Dreyer *et al.* 2023a) that a significant portion of the planktotrophic y-naupliar fauna at Sesoko Island may have been transported from afar, e.g., by the Kuroshio Current, due to the presumed long larval life-span and molt-timing of these forms. As for lecithotrophs, however, at Sesoko most of the freshly sampled y-nauplii were very early in development (e.g., Fig. 1A–B), and the naupliar phase of development of all lecithotrophs was relatively fast (< 11 days, often only 4 days; Table 1). We therefore assume that a significant fraction of the lecithotrophic nauplii sampled in the present study was of local origin.

Regression analysis of specimen numbers versus body size (expressed as length) in our material demonstrated a real, albeit moderate, tendency of fewer specimens of larger morphospecies and more specimens of smaller morphospecies. Could there be a causal connection between these parameters? Larger morphospecies might also have larger eggs, and thus smaller brood sizes, or perhaps their breeding populations are smaller. Perhaps the large, disc-shaped morphospecies, possibly being better adapted than others for long-distance dispersal owing to increased drifting capability, arrive from afar and are therefore generally fewer in number. Such hypotheses cannot be addressed until the nature and distribution of the still-unknown adult facetotectans have been understood. Unfortunately, the outlined diversity of y-naupliar morphospecies, even when combined with information about the tempo of naupliar development, feeding mode, diurnal rhythms and cyprid morphology, appears to tell us almost nothing about those adults. The fact that freshly sampled lecithotrophic y-nauplii are generally early stages, requiring several molts to reach the LSN stage (and subsequently the cyprid), hints tantalizingly that the elusive adults are to be found in shallow waters not far away from the collecting site. They may exist there as undetected endoparasites, as has been suggested earlier (Glenner *et al.* 2008; Dreyer *et al.* 2023a, 2023b).

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Appendix

Table S1 (on following pages). Complete list of y-nauplii (Crustacea: Facetotecta) from 1991–2005, 2018 and 2019 examined for each morphospecies/species. The table includes information such as various reference numbers (sample # and museum #), measurements (length), sampling date and information about naupliar development. Some of the data has been summarized in Table 1. Examples of live video of most of the y-naupliar morphospecies can be seen at https://youtu.be/er0mYLswV-c and are also deposited at Figshare.com: https://doi.org/10.6084/m9.figshare.24953568.v1.

Symbols used in table:

Japan: Okinawa, pier of Tropical Biosphere Research Center Sesoko Station

^ NHMD, Natural History Museum of Denmark

* Exuvium, on glycerine jelly slide (formalin-fixed). Slides are kept temporarily in separate slide boxes in the crustacean collection at NHMD reflecting different years of field work. After formal description, relevant slides will be transferred to the general slide collection in the crustacean collection at NHMD

† SEM stub (in most cases formalin-fixed)

¤ Formalin-fixed still in uncatalogued vial. In the case of cyprids most often corresponding to catalogued LSN exuvium on slide (can be linked using JA-number)

§ Ethanol-fixed and most often processed for molecular work (resulting in lack of voucher) but sometimes used for SEM

1 Collected and processed by Danny Eibye-Jacobsen, Mark J. Grygier, Jørgen Olesen

2 Collected and processed by Mark J. Grygier

Species/ Morphospecies	Sample number	Museum number	Material/ Developmental stage	Collecting data	Length of LSN without posterior spines	Material status	Sequencing status	Days from capture to cyprid appearance	Y-larvae slide box (1–5) at NHMD[^]
Hansenocaris demodex Olesen *et al.*, 2022	JA-2018-14	NHMD-916629	LSN[*] Cyprid[†]	15 Oct. 2018[#1]	302 µm	Holotype		6	General slide collection
—‖—	JA-2018-013	NHMD-916630	LSN[*] Cyprid[†]	17 Oct. 2018[#1]	375 µm	Paratype		3	General slide collection
—‖—	JA-2018-108	NHMD-916631	LSN[*] Cyprid[§]	22 Oct. 2018[#1]	385 µm	Paratype		5	General slide collection
—‖—	JA-2018-111	No voucher	Nauplius	22 Oct. 2018[#1]	390 µm				
—‖—	JA-2018-248	NHMD-916632	LSN[*] Cyprid[†]	3 Nov. 2018[#1]	352 µm	Paratype		5	General slide collection
—‖—	JA-2018-274	NHMD-916633	Nauplius[†]	3 Nov. 2018[#1]	360 µm	Paratype			
—‖—	JA-2019-001	No voucher	Nauplius[§]	1 Jun. 2019[#1]	378 µm				
—‖—	JA-2019-320	NHMD-916635	Nauplius[†]	22 Jun. 2019[#1]	361 µm	Paratype			
—‖—	JA-2019-321	No voucher	Nauplius[§]	22 Jun. 2019[#1]	348 µm				
—‖—	JA-2019-322	No voucher	Nauplius[§]	22 Jun. 2019[#1]	369 µm				
—‖—	JA-2019-165	No voucher	LSN[§]	10 Jun. 2019[#1]	373 µm				
—‖—	JA-2019-048	NHMD-916636	LSN[†]	10 Jun. 2019[#1]	380 µm	Paratype			
—‖—	JA-2019-099	NHMD-916638	LSN (failed molting, surface is LSN-2)[†]	11 Jun. 2019[#1]	371 µm	Paratype			
—‖—	JA-2019-107	No voucher	LSN (failed molting)[§]	12 Jun. 2019[#1]	352 µm				
—‖—	JA-2019-136	No voucher	LSN (failed molting)[§]	12 Jun. 2019[#1]	Unavailable				
—‖—	JA-2019-100	No voucher	Nauplius[§]	14 Jun. 2019[#1]	Unavailable				
—‖—	JA-2019-378-0	No voucher	Nauplius[§]	20 Jun. 2019[#1]	Unavailable				
—‖—	Specimen 141	NHMD-916639	LSN[*]	29 Sep. 2005[#2]	390 µm	Paratype			General slide collection
—‖—	No number	NHMD-916640	Early nauplius[†]	21–22 Sep. 1991[#2]	345 µm				
Y-nauplius **Type C** (‘Bumblebee’)	JA-2018-071	NHMD-1201533	LSN[*] Cyprid[□]	18 Oct. 2018[#1]	Not measured			7	4
—‖—	JA-2018-077	NHMD-1699698	LSN[*] Cyprid[§]	18 Oct. 2018[#1]	270 µm		Cyprid sequenced	7	4
—‖—	JA-2018-075	NHMD-1699699	LSN[*] Cyprid[†]	18 Oct. 2018[#1]	262 µm (280 µm on slide)			7	4
—‖—	JA-2018-092	NHMD-1699700	LSN[*] Cyprid[□]	18 Oct. 2018[#1]	268 µm			8	4
—‖—	JA-2018-076	NHMD-1699701	LSN[*] Cyprid[†]	18 Oct. 2018[#1]	270 µm		Cyprid sequenced	7	4
—‖—	Dish 59 (2018)	No voucher	LSN	19 Oct. 2018[#1]	270 µm				
—‖—	JA-2018-169	NHMD-1699702	LSN[*] Cyprid[□]	24 Oct. 2018[#1]	268 µm			8	4
—‖—	JA-2018-178	No voucher	LSN	25 Oct. 2018[#1]	263 µm			7	

Species/ Morphospecies	Sample number	Museum number	Material/ Developmental stage	Collecting data	Length of LSN without posterior spines	Material status	Sequencing status	Days from capture to cyprid appearance	Y-larvae slide box (1–5) at NHMD[^]
—‖—	Dish 142B (2018)	No voucher	LSN	25 Oct. 2018[#1]	270 µm				
—‖—	Dish 145B (2018)	No voucher	LSN	26 Oct. 2018[#1]	268 µm				
—‖—	Dish 54 (2018)	No voucher	LSN	18 Oct. 2018[#1]	282 µm				
—‖—	Dish 160 (2018)	No voucher	Nauplius	27 Oct. 2018[#1]	235 µm				
—‖—	Dish 166 (2018)	No voucher	Nauplius	28 Oct. 2018[#1]	Unavailable				
—‖—	JA-2018-308	NHMD-1704821	LSN[*] Cyprid[¤]	28 Oct. 2018[#1]	262 µm			8	4
—‖—	Dish 203 (2018)	No voucher	Nauplius	29 Oct. 2018[#1]	240 µm				
—‖—	Dish 214C (2018)	No voucher	LSN	29 Oct. 2018[#1]	270 µm				
—‖—	JA-2019-124	NHMD-1704822	LSN[*] Cyprid[†]	9 Jun. 2019[#1]	268 µm (280 µm on slide)			7	5
—‖—	JA-2019-177	NHMD-1704823	LSN[*] Cyprid[§]	9 Jun. 2019[#1]	254 µm		Cyprid sequenced	9	5
—‖—	JA-2019-178	NHMD-1704824	LSN[*] Cyprid[†]	10 Jun. 2019[#1]	271 µm			8	5
—‖—	JA-2019-192	NHMD-1704825	LSN[*] Cyprid[§]	11 Jun. 2019[#1]	261 µm		Cyprid sequenced	8	5
—‖—	JA-2019-195	NHMD-1704826	LSN[*] Cyprid[¤]	11 Jun. 2019[#1]	260 µm			8	5
—‖—	JA-2019-207	NHMD-1704827	LSN[*] Cyprid[§]	11 Jun. 2019[#1]	270 µm		Cyprid sequenced	8	5
—‖—	Dish 114B (2019)	No voucher	LSN	12 Jun. 2019[#1]	260 µm				5
—‖—	JA-2019-084	Uncatalogued	Nauplius[¤]	11 Jun. 2018[#1]	Not measured				
—‖—	JA-2019-201	NHMD-1704829	LSN[*] Cyprid[†]	12 Jun. 2019[#1]	270 µm				5
—‖—	JA-2019-199	NHMD-1704830	LSN[*] Cyprid[§]	11 Jun. 2019[#1]	260 µm			8	5
—‖—	JA-2019-226	NHMD-1704831	LSN[*] Cyprid[§]	12 Jun. 2019[#1]	264 µm			8	5
—‖—	Dish 142 (2019)	No voucher	Nauplius	6 Jun. 2019[#1]	225 µm				
—‖—	JA-2019-231	NHMD-1704832	LSN[*] Cyprid[†]	12 Jun. 2019[#1]	265 µm			8	5
—‖—	JA-2019-225	NHMD-1704833	LSN[*] Cyprid[¤]	12 Jun. 2019[#1]	265 µm			8	4
—‖—	Dish 147B (2019)	No voucher	LSN	14 Jun. 2019[#1]	252 µm				
—‖—	JA-2019-227	NHMD-1704834	LSN[*] Cyprid[¤]	12 Jun. 2019[#1]	251 µm			8	5
—‖—	Dish 164 (2019)	No voucher	LSN	14 Jun. 2019[#1]	262 µm				
—‖—	Dish 169C (2019)	No voucher	LSN	14 Jun. 2019[#1]	275 µm				
—‖—	JA-2019-289	NHMD-1704835	LSN[*] Cyprid[¤]	14 Jun. 2019[#1]	270 µm			8	5
—‖—	JA-2019-294	NHMD-1704836	LSN[*] Cyprid[†]	14 Jun. 2019[#1]	269 µm			8	5
—‖—	JA-2019-293	NHMD-1704837	LSN[*] Cyprid[¤]	14 Jun. 2019[#1]	260 µm			8	5
—‖—	JA-2019-292	NHMD-1704838	LSN[*] Cyprid[¤]	14 Jun. 2019[#1]	268 µm			8	5
—‖—	Dish 203A (2019)	No voucher	LSN	13 Jun. 2019[#1]	260 µm				
—‖—	Dish 204F (2019)	No voucher	LSN	13 Jun. 2019[#1]	270 µm				
—‖—	JA-2019-266	NHMD-1704839	LSN[*] Cyprid[§]	13 Jun. 2019[#1]	255 µm			8	5

Species/ Morphospecies	Sample number	Museum number	Material/ Developmental stage	Collecting data	Length of LSN without posterior spines	Material status	Sequencing status	Days from capture to cyprid appearance	Y-larvae slide box (1–5) at NHMD[^]
—‖—	JA-2019-296	NHMD-1704840	LSN[*] Cyprid[§]	15 Jun. 2019[#1]	255 µm			7	5
—‖—	JA-2019-360	NHMD-1704841	LSN[§†]	16 Jun. 2019[#1]	255 µm				
—‖—	JA-2019-325	NHMD-1704842	Nauplius[†]	20 Jun. 2019[#1]	240 µm				
—‖—	Dish 11 (2019)	No voucher	Nauplius	9 Jun. 2019[#1]	225 µm				
—‖—	Dish 11 (2019)	No voucher	Nauplius	9 Jun. 2019[#1]	230 µm				
—‖—	Dish 20 (2019)	No voucher	Nauplius	20 Jun. 2019[#1]	235 µm				
—‖—	Specimen 189	NHMD-1704843	LSN[*]	28 Sep. 2005[#2]	276 µm				3
—‖—	Specimen 190	NHMD-1704844	LSN[*]	28 Sep. 2005[#2]	270 µm				3
—‖—	Specimen 75	NHMD-1704845	LSN[*]	23 Sep. 2005[#2]	290 µm				3
—‖—	Specimen 188	NHMD-1704846	LSN[*]	28 Sep. 2005[#2]	265 µm				3
—‖—	Specimen 178	NHMD-1704847	LSN[*]	28 Sep. 2005[#2]	282 µm				3
—‖—	Specimen 115	NHMD-1704848	LSN[*]	25 Sep. 2005[#2]	275 µm				3
—‖—	Specimen 116	NHMD-1704849	LSN[*]	25 Sep. 2005[#2]	275 µm				3
—‖—	Specimen 131	NHMD-1704850	LSN[*]	26 Sep. 2005[#2]	260 µm				3
Y-nauplius **Type D*** (‘Big brown’)	JA-2018-046	NHMD-1704851	LSN[*] Cyprid[¤]	18 Oct. 2018[#1]	310 µm			6	4
—‖—	JA-2018-270	Uncatalogued	Nauplius[¤]	3 Nov. 2018[#1]	300 µm				
—‖—	JA-2018-279	Uncatalogued	Nauplius[¤]	3 Nov. 2018[#1]	290 µm				
—‖—	JA-2018-044	NHMD-1704852	LSN[*] Cyprid[¤]	18 Oct. 2018[#1]	330 µm			5	4
—‖—	Dish 176 (2018)	No voucher	LSN	28 Oct. 2018[#1]	320 µm				
—‖—	Dish 208 (2018)	No voucher	LSN	29 Oct. 2018[#1]	335 µm				
—‖—	Dish 230B - 2018	No voucher	LSN	5 Nov. 2018[#1]	340 µm				
—‖—	Dish 141A (2019)	No voucher	LSN	12 Jun. 2019[#1]	325 µm				
—‖—	Dish 146A - 2019	No voucher	LSN	12 Jun. 2019[#1]	320 µm				
—‖—	Dish 158A - 2019	No voucher	LSN	6 Jun. 2019	330 µm				
—‖—	JA-2019-216	NHMD-1704853	LSN[*] Cyprid[¤]	14 Jun. 2019[#1]	315 µm			6	5
—‖—	JA-2018-101	NHMD-1704854	LSN[*] Cyprid[§]	22 Oct. 2018[#1]	315 µm		Cyprid sequenced	4	4
—‖—	JA-2018-154	NHMD-1704855	LSN[*] Cyprid[§]	25 Oct. 2018[#]	325 µm (slide) 320 µm (live)		Cyprid sequenced	6	4
—‖—	JA-2018-162	No voucher	LSN[§]	26 Oct. 2018[#1]	350 µm		LSN sequenced	5	
—‖—	JA-2018-156	Uncatalogued	LSN[¤]	27 Oct. 2018[#1]	330 µm				
—‖—	JA-2018-330	NHMD-1704856	LSN[*] Cyprid[¤]	29 Oct. 2018[#1]	320 µm			7	4
—‖—	JA-2018-157	NHMD-1704857	LSN[*] Cyprid[†]	25 Oct. 2018[#1]	320 µm			7	4
—‖—	JA-2018-286	NHMD-1704858	LSN[*] Cyprid[†]	29 Oct. 2018[#!]	340 µm			6	4
—‖—	JA-2018-311	NHMD-1704859	LSN[*] Cyprid[¤]	31 Oct. 2018[#1]	Not measured			5	4

Species/ Morphospecies	Sample number	Museum number	Material/ Developmental stage	Collecting data	Length of LSN without posterior spines	Material status	Sequencing status	Days from capture to cyprid appearance	Y-larvae slide box (1–5) at NHMD[^]
—‖—	JA-2018-312	NHMD-1704860	LSN[*] Cyprid[¤]	31 Oct. 2018[#1]	Not measured			5	4
—‖—	JA-2018-319	No voucher	LSN[§]	31 Oct. 2018[#1]	330 µm		Not yet sequenced		
—‖—	JA-2018-318	No voucher	LSN[§]	31 Oct. 2018[#1]	340 µm		LSN sequenced		
—‖—	JA-2018-323	Uncatalogued	LSN[¤]	31 Oct. 2018[#1]	340 µm				
—‖—	JA-2019-181	NHMD-1704861	LSN[*] Cyprid[§]	11 Jun. 2019[#1]	320 µm		Cyprid sequenced	8	5
—‖—	JA-2019-176	NHMD-1704862	LSN[*] Cyprid[¤]	12 Jun. 2019	310 µm			6	5
—‖—	JA-2019-180	NHMD-1704863	LSN[*] Cyprid[¤]	12 Jun. 2019[#1]	340 µm			7	5
—‖—	JA-2019-205	NHMD-1704864	LSN[*] Cyprid[§]	13 Jun. 2019[#1]	325 µm		Cyprid sequenced	6	5
—‖—	JA-2019-204	NHMD-1704865	LSN[*] Cyprid[¤]	14 Jun. 2019[#1]	350 µm			5	5
—‖—	JA-2019-198	NHMD-1704866	LSN[*] Cyprid[¤]	14 Jun. 2019[#1]	320 µm			5	5
—‖—	JA-2019-286	NHMD-1704867	LSN[*] Cyprid[§]	14 Jun. 2019[#1]	Not measured		Cyprid sequenced	6	5
—‖—	JA-2019-277	NHMD-1704868	LSN[*] Cyprid[¤]	15 Jun. 2019[#1]	Not measured			6	5
—‖—	JA-2019-189	NHMD-1704869	LSN[*] Cyprid[¤]	13 Jun. 2019[#1]	320 µm			6	5
—‖—	JA-2019-200	NHMD-1704870	LSN[*] Cyprid[§]	13 Jun. 2019[#1]	320 µm		Cyprid sequenced	6	5
—‖—	JA-2019-197	NHMD-1704871	LSN[*] Cyprid[¤]	13 Jun. 2019[#1]	295 µm			6	5
—‖—	JA-2019-196	NHMD-1704872	LSN[*] Cyprid[§]	13 Jun. 2019[#1]	300 µm		Cyprid sequenced	6	5
—‖—	JA-2019-353	No voucher	LSN[§]	15 Jun. 2019[#1]	320 µm		Not yet sequenced		
—‖—	JA-2019-275	NHMD-1704873	LSN[*] Cyprid[§]	15 Jun. 2019[#1]	335 µm		Cyprid sequenced	6	5
—‖—	JA-2019-279	NHMD-1704874	LSN[*] Cyprid[§]	16 Jun. 2019[#1]	Not measured		Cyprid sequenced	5	5
—‖—	JA-2019-298	No voucher	Nauplius[§]	20 Jun. 2019[#1]	Not measured		Nauplius sequenced		
—‖—	Specimen 92	NHMD-1704875	LSN[*]	25 Sep. 2005[#2]	360 µm				3
—‖—	Specimen 192	NHMD-1704876	LSN[*]	30 Sep. 2005[#2]	325 µm				3
—‖—	Slide 80	NHMD-1704877	LSN[*]	17 Oct. 2003[#2]	350 µm				1
—‖—	Slide DK 97	NHMD-1704878	LSN[*]	19 Aug. 1996[#2]	360 µm				1

Species/ Morphospecies	Sample number	Museum number	Material/ Developmental stage	Collecting data	Length of LSN without posterior spines	Material status	Sequencing status	Days from capture to cypris appearance	Y-larvae slide box (1–5) at NHMD[^]
Y-nauplius **Type B**	JA-2019-348	No voucher	LSN[§]	14 Jun. 2019[#1]	275 µm (from side) 250 µm (from ventral)		LSN sequenced		
—‖—	JA-2019-284	NHMD-1704879	LSN[*] Cypris[¤]	6 Jun. 2019[#1]	265 µm			11	5
—‖—	JA-2019-346	No voucher	LSN[§]	12 Jun. 2019[#1]	265 µm		LSN sequenced		
—‖—	Slide DK 49	NHMD-1704880	LSN[*]	16–18 Jul. 1996[#2]	300 µm (exuvium squeezed)				2
Y-nauplius **Type F**	Dish 86A (2018)	No voucher	LSN	22 Oct. 2018[#1]	300 µm				
—‖—	JA-2019-138	NHMD-1704881	LSN[*] Cypris[§]	12 Jun. 2019[#1]	300 µm (from ventral), 320 µm (from lateral), 375 µm (slide)		Cypris sequenced	5	5
—‖—	Dish 124H (2019)	No voucher	LSN	12 Jun. 2019[#1]	300 µm				
—‖—	JA-2019-347	No voucher	LSN[§]	14 Jun. 2019[#1]	300 µm		LSN sequenced		
—‖—	Dish 225 (2019)	No voucher	LSN	15 Jun. 2019[#1]	300 µm				
—‖—	Slide DK 99	NHMD-1704882	LSN[*]	19 Aug. 1996[#2]	300 µm				2
—‖—	Specimen 156	NHMD-1704883	LSN[*]	26 Sep. 2005[#2]	375 µm (lateral)				3
Y-nauplius **Type G**	JA-2018-321	No voucher	LSN[§]	10 Oct. 2018[#1]	300 µm		LSN sequenced		
—‖—	JA-2018-314	Uncatalogued	LSN[¤]	30 Oct. 2018[#1]	305 µm				
—‖—	Dish 215B (2018)	No voucher	LSN	29 Oct. 2018[#1]	300 µm				
—‖—	Dish 183 (2018)	No voucher	LSN	28 Oct. 2018[#1]	300 µm				
—‖—	JA-2019-113	NHMD-1704884	LSN[*] Cypris[¤]	19 Jun. 2019[#1]	300 µm (lateral)			7	5
—‖—	JA-2019-143	NHMD-1704885	LSN[*] Cypris[¤]	10 Jun. 2019[#1]	320 µm (lateral)			7	5
—‖—	JA-2019-175	NHMD-1704886	LSN[*] Cypris[¤]	11 Jun. 2019[#1]	300 µm (lateral) 350 µm (slide, lateral)			7	5
—‖—	JA-2019-086	Uncatalogued	Early nauplius[¤]	11 Jun. 2019[#1]	Not measured				
—‖—	JA-2019-088	Uncatalogued	Early nauplius[¤]	11 Jun. 2019[#1]	Not measured				
—‖—	JA-2019-089	Uncatalogued	Early nauplius[¤]	11 Jun. 2019[#1]	Not measured				
—‖—	JA-2019-090	Uncatalogued	Early nauplius[¤]	11 Jun. 2019[#1]	Not measured				
—‖—	Dish 124F (2019)	No voucher	LSN	11 Jun. 2019[#1]	Not measured				
—‖—	Dish 124G (2019)	No voucher	LSN	11 Jun. 2019[#1]	Not measured				
—‖—	JA-2019-179	NHMD-1704887	LSN[*] Cypris[§]	12 Jun. 2019[#1]	320 µm (but specimen oblique)		Cypris sequenced	6	5

Species/ Morphospecies	Sample number	Museum number	Material/ Developmental stage	Collecting data	Length of LSN without posterior spines	Material status	Sequencing status	Days from capture to cyprid appearance	Y-larvae slide box (1–5) at NHMD$^{\wedge}$
—‖—	JA-2019-344	No voucher	LSN§	12 Jun. 2019$^{\#1}$	320 µm (but specimen oblique)		LSN sequenced		
—‖—	Dish 145B (2019)	No voucher	LSN§	12 Jun. 2019$^{\#1}$	300 µm (but specimen oblique)				
—‖—	JA-2019-186	NHMD-1704888	LSN* Cyprid$^{\square}$	12 Jun. 2019$^{\#1}$	275 µm (but specimen oblique)			7	5
—‖—	JA-2019-168	No voucher	LSN§	12 Jun. 2019$^{\#1}$	275 µm (but specimen oblique)		LSN sequenced		
—‖—	JA-2019-194	NHMD-1704889	LSN* Cyprid§	12 Jun. 2019$^{\#1}$	325 µm (but specimen oblique)		Cyprid sequenced	7	5
—‖—	Dish 201I (2019)	No voucher	LSN	12 Jun. 2019$^{\#1}$	300 µm (but specimen oblique)				
—‖—	Dish 242C (2019)	No voucher	LSN	16 Jun. 2019$^{\#1}$	300 µm (but specimen oblique)				
—‖—	JA-2019-367	No voucher	LSN§	16 Jun. 2019$^{\#1}$	275 µm (but specimen oblique)		LSN sequenced		
—‖—	Slide DK 40	NHMD-1704890	LSN*	16–19 Jul. 1996$^{\#2}$	350 µm				2
—‖—	Slide DK 71	NHMD-1704891	LSN*	19 Aug. 1996$^{\#2}$	360 µm				2
—‖—	Specimen 90	NHMD-1704892	LSN*	24 Sep. 2005$^{\#2}$	(no side view available)				3
Y-nauplius **Type H**	JA-2018-091	NHMD-1704893	LSN* Cyprid†	18 Oct. 2018$^{\#1}$	350 µm			8	4
—‖—	JA-2018-096	No voucher	LSN§	18 Oct. 2018$^{\#1}$	300 µm (oblique specimen)		LSN sequenced		
—‖—	JA-2018-315								
	No voucher	LSN§	5 Nov. 2018$^{\#1}$	310 µm			LSN sequenced		
—‖—	JA-2019-190	NHMD-1704894	LSN* Cyprid†	10 Jun. 2019$^{\#1}$	350 µm			9	5
—‖—	JA-2019-043	Uncatalogued	9 early nauplii$^{\square}$	11 Jun. 2019$^{\#1}$	Not measured				
—‖—	JA-2019-087	Uncatalogued	Nauplius$^{\square}$	11 Jun. 2019$^{\#1}$	Not measured				
—‖—	Dish 201G (2019)	No voucher	LSN	12 Jun. 2019$^{\#1}$	380 µm				
—‖—	JA-2019-243	No voucher	Early nauplius	20 Jun. 2019$^{\#1}$	Not measured		Nauplius sequenced		
—‖—	JA-2019-262	No voucher	Early nauplius	20 Jun. 2019$^{\#1}$	Not measured		Nauplius sequenced		
—‖—	JA-2019-039	No voucher	Early nauplius	9 Jun. 2019$^{\#1}$	Not measured		Nauplius sequenced		
Hansenocaris cristalabri Olesen & Grygier, 2022	JA-2019-137	NHMD-1174814	LSN†	10 Jun. 2019$^{\#1}$	335 µm	Holotype			SEM collection

Species/ Morphospecies	Sample number	Museum number	Material/ Developmental stage	Collecting data	Length of LSN without posterior spines	Material status	Sequencing status	Days from capture to cyprid appearance	Y-larvae slide box (1–5) at NHMD[^]
Hansenocaris aquila Olesen & Grygier, 2022	Specimen 20	NHMD-1174815	LSN[*]	22 Sep. 2005[#2]	395 µm	Holotype			General slide collection
—‖—	Slide DK 20	NHMD-1174816	LSN[*]	16–19 Jul. 1996[#2]	400 µm	Paratype			General slide collection
Y-nauplius **Type AC**	JA-2018-350	No voucher	LSN[§]	30 Oct. 2018	280 µm		LSN sequenced		
Y-nauplius **Type AH***	JA-2018-033	NHMD-1704895	LSN[*] Cyprid[¤]	18 Oct. 2018[#1]	260 µm (live from ventral)			4	4
—‖—	JA-2018-012	NHMD-1704896	LSN[*] Cyprid[¤]	18 Oct. 2018[#1]	230 µm (live from ventral)			2	4
—‖—	JA-2018-099	NHMD-1704897	LSN[*] Cyprid[§]	22 Oct. 2018[#1]	270 µm (live from ventral)		Cyprid sequenced	4	4
—‖—	JA-2018-109	NHMD-1704898	LSN[*] Cyprid[†]	22 Oct. 2018[#1]	270 µm (live from ventral), 270 µm (slide from lateral)			5	4
—‖—	JA-2018-160	No voucher	LSN[§]	24 Oct. 2018[#1]	250 µm (live from ventral)		LSN sequenced	7	
—‖—	JA-2018-171	NHMD-1704899	LSN[*] Cyprid[§]	28 Oct. 2018[#1]	260 µm (live from ventral)		Cyprid sequenced	4	4
—‖—	JA-2018-194	NHMD-1704900	LSN[*] Cyprid[†]	28 Oct. 2018[#1]	240 µm (live from ventral)			5	4
—‖—	JA-2018-283	NHMD-1704901	LSN[*] Cyprid[§]	30 Oct. 2018[#1]	260 µm (live from ventral)		Cyprid sequenced	5	4
—‖—	JA-2018-246	NHMD-1704902	LSN[*] Cyprid[†]	30 Oct. 2018[#1]	250 µm (live from ventral)			4	4
—‖—	JA-2018-220	NHMD-1704903	LSN[*] Cyprid[§]	30 Oct. 2018[#1]	270 µm (live from ventral)		Cyprid sequenced	4	4
—‖—	JA-2018-264	NHMD-1704904	LSN[*] Cyprid[§]	30 Oct. 2018[#1]	270 µm (live from ventral)		Cyprid sequenced	4	4
—‖—	JA-2018-221	NHMD-1704905	LSN[*] Cyprid[†]	30 Oct. 2018[#1]	240 µm (live from ventral)			4	4
—‖—	JA-2018-223	NHMD-1704906	LSN[*] Cyprid[†]	30 Oct. 2018[#1]	250 µm (live from ventral)			4	4
—‖—	JA-2019-053	NHMD-1704907	LSN[*] Cyprid[¤]	9 Jun. 2019[#1]	260 µm (live from ventral)			4	5
—‖—	JA-2019-059	NHMD-1704908	LSN[*] Cyprid[§]	9 Jun. 2019[#1]	250 µm (live from ventral)		Cyprid sequenced	5	5

Species/ Morphospecies	Sample number	Museum number	Material/ Developmental stage	Collecting data	Length of LSN without posterior spines	Material status	Sequencing status	Days from capture to cyprid appearance	Y-larvae slide box (1–5) at NHMD^
—‖—	JA-2019-058	NHMD-1704909	LSN* Cyprid□	9 Jun. 2019#1	260 µm (live from ventral)			5	5
—‖—	JA-2019-061	NHMD-1704910	LSN* Cyprid†	9 Jun. 2019#1	240 µm (live from ventral)			5	5
—‖—	JA-2019-070	NHMD-1704911	LSN* Cyprid§	9 Jun. 2019#1	260 µm (live from ventral)			5	5
—‖—	JA-2019-283	NHMD-1710458	LSN* Cyprid§	16 Jun. 2019#1	Not measured				5
—‖—	JA-2019-097	NHMD-1704912	LSN* Cyprid§	10 Jun. 2019#1	280 µm (live from ventral)		Cyprid sequenced	5	5
—‖—	JA-2019-063	NHMD-1704913	LSN* Cyprid§	10 Jun. 2019#1	260 µm (live from ventral)		Cyprid sequenced	4	5
—‖—	JA-2019-066	NHMD-1704914	LSN* Cyprid§	10 Jun. 2019#1	260 µm (live from ventral)		Cyprid sequenced	4	5
—‖—	JA-2019-096	NHMD-1704915	LSN* Cyprid†	10 Jun. 2019#1	270 µm (live from ventral)			5	5
—‖—	JA-2019-071	NHMD-1704916	LSN* Cyprid□	10 Jun. 2019#1	260 µm (live from ventral)			4	5
—‖—	JA-2019-072	NHMD-1704917	LSN* Cyprid§	10 Jun. 2019#1	270 µm (live from ventral)		Cyprid sequenced	4	5
—‖—	JA-2019-073	NHMD-1704918	LSN* Cyprid†	10 Jun. 2019#1	260 µm (live from ventral)			4	5
—‖—	JA-2019-203	NHMD-1704919	LSN* Cyprid§	14 Jun. 2019#1	250 µm (live from ventral)			5	5
—‖—	JA-2019-169	NHMD-1704920	LSN§†	14 Jun. 2019#1	270 µm (live from ventral)				
—‖—	JA-2019-274	NHMD-1704921	LSN* Cyprid†	16 Jun. 2019#1	270 µm (live from ventral)			5	5
—‖—	JA-2019-357	NHMD-1704923	LSN* Cyprid§	15 Jun. 2019#1	280 µm (live from ventral)		Cyprid sequenced	8	5
—‖—	JA-2019-163	NHMD-1704924	LSN* Cyprid§	12 Jun. 2019#1	270 µm (live from ventral)		Cyprid sequenced	6	5
—‖—	JA-2019-170	NHMD-1704925	LSN†	14 Jun. 2019#1	250 µm (live from ventral)				
—‖—	Specimen 30	NHMD-1704926	LSN*	24 Sep. 2005#2	320 µm (slide from ventral)				3
—‖—	Specimen 99	NHMD-1704927	LSN*	26 Sep. 2005#2	275 µm (slide from ventral)				3
—‖—	Specimen 2	NHMD-1704928	LSN*	22 Sep. 2005#2	310 µm (slide from ventral)				3

Species/ Morphospecies	Sample number	Museum number	Material/ Developmental stage	Collecting data	Length of LSN without posterior spines	Material status	Sequencing status	Days from capture to cyprid appearance	Y-larvae slide box (1–5) at NHMD$^{\wedge}$
—‖—	Specimen 103	NHMD-1704929	LSN*	26 Sep. 2005$^{\#2}$	275 μm (slide from ventral)				3
—‖—	Specimen 100	NHMD-1704930	LSN*	26 Sep. 2005$^{\#2}$	270 μm (slide from ventral)				3
—‖—	Specimen 76	NHMD-1704931	LSN*	24 Sep. 2005$^{\#2}$	270 μm (slide from ventral)				3
—‖—	Specimen 39	NHMD-1704932	LSN*	25 Sep. 2005$^{\#2}$	250 μm (slide from ventral)				3
—‖—	Slide 17	NHMD-1704933	LSN*	13–21 Oct. 2004$^{\#2}$	260 μm (slide from ventral)				1
—‖—	Specimen 13	NHMD-1704934	LSN*	23 Sep. 2005$^{\#2}$	260 μm (slide from ventral)				3
—‖—	Specimen 170 or 171	NHMD-1704935	LSN*	30 Sep. 2005$^{\#2}$	260 μm (slide from ventral)				3
—‖—	Specimen 49	NHMD-1704936	LSN*	24 Sep. 2005$^{\#2}$	275 μm (slide from ventral)				3
Y-nauplius **Type E***	JA-2018-016	NHMD-1704937	LSN* Cyprid$^{\square}$	20 Oct. 2018$^{\#1}$	240 μm (live from ventral)			1	4
—‖—	Dish 73A (2018)	No voucher	LSN	21 Oct. 2018$^{\#1}$	230 μm				
—‖—	JA-2018-074	NHMD-1704938	LSN* Cyprid§	20 Oct. 2018$^{\#1}$	220 μm (live from ventral)		Cyprid sequenced	5	4
—‖—	Dish 94A (2018)	No voucher	LSN	22 Oct. 2018$^{\#1}$	250 μm (live from ventral)				
—‖—	Dish 94C (2018)	No voucher	LSN	22 Oct. 2018$^{\#1}$	240 μm (live from ventral)				
—‖—	JA-2018-093	NHMD-1704939	LSN* Cyprid§	22 Oct. 2018$^{\#1}$	230 μm (live from ventral)		Cyprid sequenced	4	4
—‖—	JA-2018-176	No voucher	LSN§	28 Oct. 2018$^{\#1}$	220 μm (live from ventral)				
—‖—	JA-2018-346	Uncatalogued	LSN$^{\square}$	29 Oct. 2018$^{\#1}$	250 μm (live from ventral)				
—‖—	JA-2018-218	NHMD-1704940	LSN* Cyprid§	29 Oct. 2018$^{\#1}$	210 μm (live from ventral)		Cyprid sequenced	5	4
—‖—	JA-2018-249	NHMD-1704941	LSN* Cyprid§	30 Oct. 2018$^{\#1}$	260 μm (live from ventral)		Cyprid sequenced	4	4
—‖—	JA-2018-245	NHMD-1704942	LSN* Cyprid§	30 Oct. 2018$^{\#1}$	250 μm (live from ventral)		Cyprid sequenced	4	4
—‖—	JA-2018-219	NHMD-1704943	LSN* Cyprid$^{\square}$	30 Oct. 2018$^{\#1}$	220 μm (live from ventral)			4	4

Species/ Morphospecies	Sample number	Museum number	Material/ Developmental stage	Collecting data	Length of LSN without posterior spines	Material status	Sequencing status	Days from capture to cyprid appearance	Y-larvae slide box (1–5) at NHMD[^]
—‖—	JA-2018-222	NHMD-1704944	LSN[*] Cyprid[§]	30 Oct. 2018[#1]	250 µm (live from ventral)		Cyprid sequenced	4	4
—‖—	JA-2018-217	NHMD-1704945	LSN[*] Cyprid[¤]	30 Oct. 2018[#1]	250 µm (live from ventral)			4	4
—‖—	JA-2018-269	NHMD-1704946	LSN[*] Cyprid[§]	30 Oct. 2018[#1]	250 µm (live from ventral)		Cyprid sequenced	4	4
—‖—	JA-2018-224	NHMD-1704947	LSN[*] Cyprid[§]	30 Oct. 2018[#1]	220 µm (live from ventral)		Cyprid sequenced	4	4
—‖—	JA-2018-303	No voucher	LSN[§]	31 Oct. 2018[#1]	220 µm (live from ventral)			4	
—‖—	JA-2018-317	Uncatalogued	LSN[¤]	31 Oct. 2018[#1]	220 µm (live from ventral)			5	
—‖—	JA-2018-325	No voucher	LSN[§]	31 Oct. 2018[#1]	260 µm (live from ventral)			5	
—‖—	JA-2018-358	Uncatalogued	LSN[¤]	31 Oct. 2018[#1]	270 µm (live from ventral)			5	
—‖—	JA-2019-054	NHMD-1704948	LSN[*] Cyprid[¤]	9 Jun. 2019[#1]	220 µm (live from ventral)			4	5
—‖—	JA-2019-052	NHMD-1704949	LSN[*] Cyprid[¤]	9 Jun. 2019[#1]	240 µm (live from ventral)			4	5
—‖—	JA-2019-057	NHMD-1704950	LSN[*] Cyprid[§]	9 Jun. 2019[#1]	240 µm (live from ventral)		Cyprid sequenced	5	5
—‖—	JA-2019-055	NHMD-1704951	LSN[*] Cyprid[§]	9 Jun. 2019[#1]	250 µm (live from ventral)		Cyprid sequenced	4	5
—‖—	JA-2019-051	NHMD-1704952	LSN[*] Cyprid[§]	9 Jun. 2019[#1]	230 µm (live from ventral)			4	5
—‖—	JA-2019-123	NHMD-1704953	LSN[*] Cyprid[§]	10 Jun. 2019[#1]	260 µm (live from ventral)			6	5
—‖—	JA-2019-068	NHMD-1704954	LSN[*] Cyprid[¤]	10 Jun. 2019[#1]	230 µm (live from ventral)			4	5
—‖—	JA-2019-139	NHMD-1704955	LSN[*] Cyprid[¤]	10 Jun. 2019[#1]	240 µm (live from ventral)			7	5
—‖—	JA-2019-065	NHMD-1704956	LSN[*] Cyprid[¤]	10 Jun. 2019[#1]	220 µm (live from ventral)			4	5
—‖—	JA-2019-067	NHMD-1704957	LSN[*] Cyprid[¤]	10 Jun. 2019[#1]	220 µm (live from ventral)			4	5
—‖—	JA-2019-081	No voucher	LSN[§]	11 Jun. 2019[#1]	220 µm (live from ventral)				

Species/ Morphospecies	Sample number	Museum number	Material/ Developmental stage	Collecting data	Length of LSN without posterior spines	Material status	Sequencing status	Days from capture to cyprid appearance	Y-larvae slide box (1–5) at NHMD$^{\wedge}$
—‖—	JA-2019-062	Uncatalogued	LSN$^{¤}$	11 Jun. 2019$^{\#1}$	210 µm (live from ventral)				
—‖—	JA-2019-115	NHMD-1704958	LSN* Cyprid§	11 Jun. 2019$^{\#1}$	220 µm (live from ventral)		Cyprid sequenced	5	5
—‖—	JA-2019-116	NHMD-1704959	LSN* Cyprid$^{¤}$	12 Jun. 2019$^{\#1}$	210 µm (live from ventral)			4	
—‖—	JA-2019-218	NHMD-1704960	LSN* Cyprid§	14 Jun. 2019$^{\#1}$	210 µm (live from ventral)			4	5
—‖—	JA-2019-188	NHMD-1704961	LSN* Cyprid§	14 Jun. 2019$^{\#1}$	240 µm (live from ventral)		Cyprid sequenced	5	
—‖—	JA-2019-114	NHMD-1704962	LSN* Cyprid$^{¤}$	12 Jun. 2019$^{\#1}$	220 µm (live from ventral)			4	5
—‖—	JA-2019-109	NHMD-1704963	LSN* Cyprid$^{¤}$	12 Jun. 2019$^{\#1}$	210 µm (live from ventral)			4	5
—‖—	JA-2019-117	NHMD-1704964	LSN* Cyprid§	12 Jun. 2019$^{\#1}$	210 µm (live from ventral)			4	5
—‖—	JA-2019-276	NHMD-1704965	LSN* Cyprid§	16 Jun. 2019$^{\#1}$	240 µm (live from ventral)		Cyprid sequenced	5	5
—‖—	Specimen 23	NHMD-1704966	LSN*	24 Sep. 2005$^{\#2}$	230 µm (slide from ventral)				3
—‖—	Slide 7	NHMD-1704967	LSN*	13–21 Oct. 2004$^{\#2}$	240 µm (slide from ventral)				1
—‖—	Specimen 27	NHMD-1704968	LSN*	24 Sep. 2005$^{\#2}$	220 µm (slide from ventral)				3
—‖—	Specimen 24	NHMD-1704969	LSN*	24 Sep. 2005$^{\#2}$	250 µm (slide from ventral)				3
—‖—	Specimen 72	NHMD-1704970	LSN*	25 Sep. 2005$^{\#2}$	230 µm (slide from lateral)				3
—‖—	Specimen 25	NHMD-1704971	LSN*	24 Sep. 2005$^{\#2}$	220 µm (slide from ventral)				3
—‖—	Specimen 149	NHMD-1704972	LSN*	30 Sep. 2005$^{\#2}$	250 µm (slide from ventral)				3
—‖—	Slide DK 8	NHMD-1704973	LSN*	16–19 Jul. 1996$^{\#2}$	210 µm (slide from ventral)				2
—‖—	Specimen 101	NHMD-1704974	LSN*	26 Sep. 2005$^{\#2}$	250 µm (slide from ventral)				3
Y-nauplius **Type AG***	JA-2018-031	NHMD-1704975	LSN* Cyprid†	18 Oct. 2018$^{\#1}$	280 µm (live from ventral)			4	4
—‖—	JA-2018-019	NHMD-1704976	LSN* Cyprid$^{¤}$	16 Oct. 2018$^{\#1}$	310 µm (live from ventral)			4	4

Species/ Morphospecies	Sample number	Museum number	Material/ Developmental stage	Collecting data	Length of LSN without posterior spines	Material status	Sequencing status	Days from capture to cyprid appearance	Y-larvae slide box (1–5) at NHMD[^]
—‖—	JA-2018-040	NHMD-1704977	LSN[*] Cyprid[¤]	18 Oct. 2018[#1]	280 µm (live from ventral)			5	4
—‖—	JA-2018-041	NHMD-1704978	LSN[*] Cyprid[¤]	18 Oct. 2018[#1]	280 µm (live from ventral)			5	4
—‖—	JA-2018-040	NHMD-1704979	LSN[*] Cyprid[¤]	18 Oct. 2018[#1]	280 µm (live from ventral)			5	4
—‖—	JA-2018-042	NHMD-1704980	LSN[*] Cyprid[¤]	18 Oct. 2018[#1]	270 µm (live from ventral)			5	4
—‖—	JA-2018-037	NHMD-1704981	LSN[*] Cyprid[¤]	18 Oct. 2018[#1]	280 µm (slide from ventral)			5	4
—‖—	JA-2018-039	NHMD-1704982	LSN[*] Cyprid[¤]	18 Oct. 2018[#1]	280 µm (live from ventral)			5	4
—‖—	JA-2018-038	NHMD-1704983	LSN[*] Cyprid[†]	18 Oct. 2018[#1]	280 µm (live from ventral)			5	4
—‖—	JA-2018-085	NHMD-1704984	LSN[*] Cyprid[§]	20 Oct. 2018[#1]	280 µm (live from ventral)		Cyprid sequenced	5	4
—‖—	JA-2018-100	NHMD-1704985	LSN[*] Cyprid[§]	22 Oct. 2018[#1]	280 µm (live from ventral)		Cyprid sequenced	4	4
—‖—	JA-2018-115	NHMD-1704986	LSN[*] Cyprid[†]	24 Oct. 2018[#1]	270 µm (live from ventral)			4	4
—‖—	JA-2018-322	NHMD-1704987	LSN[§†]	31 Oct. 2018[#1]	270 µm (live from ventral)				
—‖—	JA-2018-320	NHMD-1704988	LSN[†]	31 Oct. 2018[#1]	280 µm (live from ventral)				
—‖—	JA-2018-324	NHMD-1704989	LSN[§†]	31 Oct. 2018[#1]	300 µm (live from ventral)				
—‖—	JA-2018-326	NHMD-1704990	LSN[†]	31 Oct. 2018[#1]	280 µm (live from ventral)				
—‖—	JA-2018-353	NHMD-1704991	LSN[§†]	31 Oct. 2018[#1]	270 µm (live from ventral)				
—‖—	JA-2018-354	No voucher	LSN[§]	31 Oct. 2018[#1]	270 µm (live from ventral)				
—‖—	JA-2019-094	NHMD-1704992	LSN[*] Cyprid[§]	9 Jun. 2019[#1]	270 µm (live from ventral)		Cyprid sequenced	6	5
—‖—	JA-2019-141	NHMD-1704993	LSN[*] Cyprid[†]	13 Jun. 2019[#1]	280 µm (live from ventral)		Cyprid sequenced	4	5
—‖—	JA-2019-174	NHMD-1704994	LSN[*] Cyprid[§]	12 Jun. 2019[#1]	290 µm (live from ventral)		Cyprid sequenced	6	5

Species/ Morphospecies	Sample number	Museum number	Material/ Developmental stage	Collecting data	Length of LSN without posterior spines	Material status	Sequencing status	Days from capture to cyprid appearance	Y-larvae slide box (1–5) at NHMD[^]
—‖—	JA-2019-221	NHMD-1704995	LSN[*] Cyprid[□]	16 Jun. 2019[#1]	250 µm (live from ventral)			4	5
—‖—	JA-2019-273	NHMD-1704996	LSN[*] Cyprid[§]	16 Jun. 2019[#1]	260 µm (live from ventral)		Cyprid sequenced	5	5
—‖—	JA-2019-267	NHMD-1704997	LSN[*] Cyprid[§]	14 Jun. 2019[#1]	280 µm (live from ventral)		Cyprid sequenced	3	5
—‖—	JA-2019-268	NHMD-1704998	LSN[*] Cyprid[†]	17 Jun. 2019[#1]	270 µm (live from ventral)			4	5
—‖—	JA-2019-271	NHMD-1704999	LSN[*] Cyprid[§]	17 Jun. 2019[#1]	270 µm (live from ventral)		Cyprid sequenced	4	5
—‖—	JA-2019-282	NHMD-1705000	LSN[*] Cyprid[†]	17 Jun. 2019[#1]	270 µm (live from ventral)			5	5
—‖—	Specimen 11	NHMD-1705001	LSN[*]	23 Sep. 2005[#2]	270 µm (slide from ventral)				3
—‖—	Specimen 5	NHMD-1705002	LSN[*]	22 Sep. 2005[#2]	275 µm (slide from ventral)				3
—‖—	Specimen 12	NHMD-1705003	LSN[*]	23 Sep. 2005[#2]	260 µm (slide from ventral)				3
—‖—	Specimen 9	NHMD-1705004	LSN[*]	23 Sep. 2005[#2]	265 µm (slide from ventral)				3
—‖—	Specimen 203	NHMD-1705005	LSN[*]	1 Oct. 2005[#2]	290 µm (slide from ventral)				3
—‖—	Specimen 36	NHMD-1705006	LSN[*]	24 Sep. 2005[#2]	270 µm (slide from ventral)				3
—‖—	Specimen 2	NHMD-1705007	LSN[*]	22 Sep. 2005[#2]	280 µm (slide from ventral)				3
—‖—	Specimen 6	NHMD-1705008	LSN[*]	2005[#2]	280 µm (slide from ventral)				3
—‖—	Slide 75	NHMD-1705009	LSN[*]	14–24 Oct. 2003[#2]	270 µm (slide from ventral)				1
—‖—	Specimen 22	NHMD-1705010	LSN[*]	23–24 Sep. 2005[#2]	280 µm (slide from ventral)				3
—‖—	Specimen 14	NHMD-1705011	LSN[*]	23 Sep. 2005[#2]	270 µm (slide from ventral)				3
—‖—	Specimen 187	NHMD-1705012	LSN[*]	1 Oct. 2005[#2]	280 µm (slide from ventral)				3
—‖—	Specimen 202	NHMD-1705013	LSN[*]	1 Oct. 2005[#2]	320 µm (slide from ventral)				3

Species/ Morphospecies	Sample number	Museum number	Material/ Developmental stage	Collecting data	Length of LSN without posterior spines	Material status	Sequencing status	Days from capture to cyprid appearance	Y-larvae slide box (1–5) at NHMD[^]
Y-nauplius **Type W**	JA-2018-034	NHMD-1705014	LSN[*] Cyprid[¤]	18 Oct. 2018[#1]	240 µm (live from ventral)				4
—‖—	JA-2018-133	NHMD-1705015	LSN[*] Cyprid[†]	24 Oct. 2018[#1]	250 µm (live from ventral)			5	4
—‖—	JA-2018-268	NHMD-1705016	LSN[*] Cyprid[§]	30 Oct. 2018[#1]	250 µm (live from ventral)		Cyprid sequenced	4	4
—‖—	JA-2018-363	Uncatalogued	LSN[¤]	31 Oct. 2018[#1]	230 µm (live from ventral)				
—‖—	JA-2019-098	NHMD-1705017	LSN[*] Cyprid[¤]	9 Jun. 2019[#1]	260 µm (live from ventral)			6	5
—‖—	JA-2019-093	NHMD-1705018	LSN[*] Cyprid[¤]	9 Jun. 2019[#1]	250 µm (live from ventral)			6	5
—‖—	JA-2019-069	NHMD-1705019	LSN[*] Cyprid[§]	10 Jun. 2019[#1]	260 µm (live from ventral)		Cyprid sequenced	4	5
—‖—	JA-2019-092	NHMD-1705020	LSN[*] Cyprid[§]	10 Jun. 2019[#1]	250 µm (live from ventral)		Cyprid sequenced	5	5
—‖—	JA-2019-272	NHMD-1705021	LSN[*] Cyprid[¤]	16 Jun. 2019[#1]	250 µm (live from ventral)			5	5
—‖—	Slide 68	NHMD-1705022	LSN[*]	14–24 Oct. 2003[#2]	280 µm (slide from ventral)				1
Y-nauplius **Type AD**	JA-2018-072	NHMD-1705023	LSN[*] Cyprid[¤]	18 Oct. 2018[#1]	330 µm (slide from ventral)			7	4
—‖—	Dish 70 (2018)	No voucher	LSN	21 Oct. 2018[#1]	320 µm (slide from ventral)				
—‖—	JA-2018-166	No voucher	LSN[§]	22 Oct. 2018[#1]	290 µm (slide from ventral)		LSN sequenced		
—‖—	JA-2019-122	NHMD-1705024	LSN[*] Cyprid[¤]	10 Jun. 2019[#1]	310 µm (slide from ventral)			6	5
—‖—	JA-2019-193	NHMD-1705025	LSN[*] Cyprid[¤]	11 Jun. 2019[#1]	310 µm (slide from ventral)			8	5
—‖—	JA-2019-215	No voucher	LSN[§]	13 Jun. 2019[#1]	300 µm (slide from ventral)				
—‖—	JA-2019-363	No voucher	LSN[§]	16 Jun. 2019[#1]	330 µm (slide from ventral)				
—‖—	JA-2019-362	No voucher	LSN[§]	16 Jun. 2019[#1]	320 µm (slide from ventral)		LSN sequenced		
—‖—	JA-2019-366	No voucher	LSN[§]	16 Jun. 2019[#1]	340 µm (slide from ventral)				
—‖—	Dish 203C (2019)	No voucher	LSN	13 Jun. 2019[#1]	300 µm (slide from ventral)				

Species/ Morphospecies	Sample number	Museum number	Material/ Developmental stage	Collecting data	Length of LSN without posterior spines	Material status	Sequencing status	Days from capture to cyprid appearance	Y-larvae slide box (1–5) at NHMD^
Y-nauplius **Type U***	JA-2018-247	No voucher	Early nauplius§	30 Oct. 2018#1	Not measured		Early nauplius sequenced		
—‖—	JA-2018-234	No voucher	Early nauplius§	20 Oct. 2019#1	Not measured		Early nauplius sequenced		
—‖—	JA-2019-355	No voucher	LSN§	17 Jun. 2019#1	460 µm		LSN sequenced		
—‖—	Dish 254 (2019)	No voucher	Early nauplius	22 Jun. 2019#1	Not measured				
—‖—	Slide DK 3	NHMD-1705026	LSN*	16–19 Jul. 1996#2	450 µm (slide from ventral)				2
Y-nauplius **Type V**	JA-2019-318	No voucher	LSN§	6 Jun. 2019#1	340 µm		LSN sequenced		
—‖—	JA-2019-371	NHMD-1705027	LSN* Cyprid¤	14 Jun. 2019#1	370 µm			9	5
—‖—	Dish 111B (2019)	No voucher	LSN	10 Jun. 2019#1	333 µm (caught inside previous exuviae)				
—‖—	Slide DK 48	NHMD-1705028	LSN*	16–18 Jul. 1996#2	390 µm				2
Y-nauplius **Type X**	Dish 234QQ (2018)	No voucher	LSN	30 Oct. 2018#1	350 µm				
—‖—	JA-2018-095	NHMD-1705029	LSN* Cyprid†	18 Oct. 2018#1	360 µm (live from ventral), 370 µm (slide from ventral)			8	4
—‖—	JA-2018-161	No voucher	LSN§	24 Oct. 2018#1	400 µm		LSN sequenced		
—‖—	JA-2018-356	Uncatalogued	LSN¤	30 Oct. 2018#1	360 µm				
—‖—	Dish 235W (2018)	No voucher	LSN	30 Oct. 2018#1	330 µm				
—‖—	JA-2018-364	No voucher	LSN§	30 Oct. 2018#1	360 µm		LSN sequenced		
—‖—	Dish 89 (2018)	No voucher	LSN	22 Oct. 2018#1	270 µm				
—‖—	JA-2019-119	NHMD-1705030	LSN* Cyprid¤	9 Jun. 2019#1	360 µm (live from ventral), 380 µm (slide from ventral)			7	5
—‖—	JA-2019-228	NHMD-1705031	LSN* Cyprid¤	12 Jun. 2019#1	340 µm			8	5
—‖—	Slide 7	NHMD-1705032	LSN*	13–21 Oct. 2004#2	370 µm (slide from ventral)				1
Y-nauplius **Type K**	JA-2018-005	NHMD-1705033	LSN* Cyprid†	19 Oct. 2018#1	190 µm			0	4
—‖—	Dish 28 (201 (2018)	No voucher	Nauplius	17 Oct. 2018#1	Not measured				

Species/ Morphospecies	Sample number	Museum number	Material/ Developmental stage	Collecting data	Length of LSN without posterior spines	Material status	Sequencing status	Days from capture to cyprid appearance	Y-larvae slide box (1–5) at NHMD[^]
—‖—	Dish 38 (2018)	No voucher	Nauplius	18 Oct. 2018[#1]	Not measured				
—‖—	Dish 60 (2018)	No voucher	LSN	19 Oct. 2018[#1]	190 µm				
—‖—	Dish 74A (2018)	No voucher	LSN	21 Oct. 2018[#1]	230 µm				
—‖—	JA-2018-094	NHMD-1705034	LSN[*] Cyprid[¤]	21 Oct. 2018[#1]	210 µm			5	4
—‖—	JA-2018-116	NHMD-1705035	LSN[*] Cyprid[§]	22 Oct. 2018[#1]	220 µm			6	4
—‖—	JA-2018-149	NHMD-1705036	LSN[*] Cyprid[§]	25 Oct. 2018[#1]	200 µm			5	4
—‖—	JA-2018-189	No voucher	LSN[§]	28 Oct. 2018[#1]	190 µm		LSN sequenced		
—‖—	JA-2018-172	No voucher	LSN[§]	28 Oct. 2018[#1]	210 µm		LSN sequenced		
—‖—	JA-2018-191	No voucher	LSN[§]	28 Oct. 2018[#1]	200 µm		LSN sequenced		
—‖—	JA-2018-195	NHMD-1705037	LSN[*] Cyprid[†]	28 Oct. 2018[#1]	200 µm			5	4
—‖—	JA-2018-297	No voucher	LSN[§]	29 Oct. 2018[#1]	220 µm				
—‖—	Dish 172A (2018)	No voucher	LSN	28 Oct. 2018[#1]	220 µm				
—‖—	Dish 174A (2018)	No voucher	LSN	28 Oct. 2018[#1]	200 µm				
—‖—	Dish 177B (2018)	No voucher	LSN	28 Oct. 2018[#1]	210 µm				
—‖—	JA-2018-359	No voucher	LSN[§]	31 Oct. 2018[#1]	220 µm				
—‖—	JA-2018-360	No voucher	LSN[§]	30 Oct. 2018[#1]	210 µm				
—‖—	JA-2018-365	No voucher	LSN[§]	30 Oct. 2018[#1]	210 µm				
—‖—	JA-2018-327	No voucher	LSN[§]	31 Oct. 2018[#1]	220 µm				
—‖—	JA-2018-329	NHMD-1705038	LSN[†]	31 Oct. 2018[#1]	210 µm				
—‖—	JA-2018-333	No voucher	LSN[§]	31 Oct. 2018[#1]	210 µm				
—‖—	JA-2018-332	No voucher	LSN[§]	31 Oct. 2018[#1]	210 µm				
—‖—	JA-2018-336	NHMD-1705039	LSN[†]	31 Oct. 2018[#1]	220 µm				
—‖—	JA-2018-335	NHMD-1705040	LSN[†]	31 Oct. 2018[#1]	200 µm				
—‖—	JA-2018-337	No voucher	LSN[§]	31 Oct. 2018[#1]	230 µm				
—‖—	JA-2018-352	Uncatalogued	LSN[¤]	31 Oct. 2018[#1]	200 µm				
—‖—	JA-2018-281	NHMD-1705041	LSN[*] Cyprid[†]	31 Oct. 2018[#1]	190 µm				4
—‖—	Specimen 82	NHMD-1705110	LSN[*]	25 Sep. 2005[#2]	210 µm				3
—‖—	Specimen 81	NHMD-1705111	LSN[*]	25 Sep. 2005[#2]	200 µm				3
—‖—	Slide 33	NHMD-1705112	LSN[*]	13 Oct. 2004[#2]	210 µm				1
—‖—	Slide 34	NHMD-1705113	LSN[*]	13 Oct. 2004[#2]	190 µm				1
Y-nauplius **Type M**	Dish 12 (2018)	No voucher	Nauplius	17 Oct. 2018[#1]	Not measured				
—‖—	Dish 33 (2018)	No voucher	Nauplius	17 Oct. 2018[#1]	Not measured				
—‖—	Dish 72A (2018)	No voucher	LSNCyprid	21 Oct. 2018[#1]	270 µm (live from ventral)			?	

Species/ Morphospecies	Sample number	Museum number	Material/ Developmental stage	Collecting data	Length of LSN without posterior spines	Material status	Sequencing status	Days from capture to cyprid appearance	Y-larvae slide box (1–5) at NHMD$^{\wedge}$
—‖—	Dish 125A (2018)	No voucher	LSN	24 Oct. 2018$^{\#1}$	310 µm (live from ventral)				
—‖—	Dish 17 (2019)	No voucher	Nauplius	17 Oct. 2018$^{\#1}$	Not measured				
—‖—	JA-2019-060	NHMD-1705114	LSN* Cyprid$^{¤}$	9 Jun. 2019$^{\#1}$	310 µm (live from ventral), 350 µm (slide from lateral)			5	5
—‖—	Dish 95A (2019)	No voucher	LSN	12 Jun. 2019$^{\#1}$	290 µm (live from ventral)				
—‖—	JA-2019-173	No voucher	LSN§	11 Jun. 2019$^{\#1}$	270 µm (live from ventral)		LSN sequenced		
—‖—	JA-2019-326	No voucher	Nauplius§	20 Jun. 2019$^{\#1}$	Not measured				
—‖—	JA-2019-162	NHMD-1705115	LSN* Cyprid§	12 Jun. 2019$^{\#1}$	310 µm (live from ventral), 330 µm (slide from lateral)		Cyprid sequenced	6	5
—‖—	Specimen 152	NHMD-1705116	LSN*	30 Sep. 2005$^{\#2}$	330 µm (slide from ventral)				3
—‖—	Slide DK 1	NHMD-1705117	LSN*	16–19 Jul. 1996$^{\#2}$	310 µm (slide from ventral)				2
—‖—	Specimen 37	NHMD-1705127	LSN*	24 Sep. 2005$^{\#2}$	320 µm (slide from ventral)				3
Y-nauplius **Type AI**	JA-2018-015	NHMD-1705132	LSN*	2 Nov. 2018$^{\#1}$	260 µm (live from ventral)				4
—‖—	JA-2018-053	NHMD-1705133	LSN* Cyprid$^{¤}$	22 Oct. 2018$^{\#1}$	220 µm (live from ventral)			2	4
—‖—	JA-2018-155	NHMD-1705134	LSN* Cyprid$^{¤}$	29 Oct. 2018$^{\#1}$	210 µm (live from ventral)			2	4
—‖—	JA-2018-173	NHMD-1705135	LSN* Cyprid$^{¤}$	30 Oct. 2018$^{\#1}$	Not measured			2	4
—‖—	JA-2019-056	NHMD-1705136	LSN* Cyprid$^{¤}$	12 Jun. 2019$^{\#1}$	200 µm (live from ventral)			2	5
—‖—	JA-2019-050	NHMD-1705137	LSN* Cyprid$^{¤}$	9 Jun. 2019$^{\#1}$	240 µm (live from ventral)			4	5
—‖—	JA-2019-041	NHMD-1705138	LSN* Cyprid$^{¤}$	9 Jun. 2019$^{\#1}$	200 µm (live from ventral)			2	5
—‖—	Dish 14 (2019)	No voucher	LSN	6 Jun. 2019$^{\#1}$	230 µm (live from ventral)				
—‖—	Slide 54	NHMD-1705139	LSN*	14–24 Oct. 2003$^{\#2}$	240 µm (live from ventral)				1
—‖—	Specimen 104	NHMD-1705140	LSN*	28 Sep. 2005$^{\#2}$	220 µm (live from ventral)				3

Species/ Morphospecies	Sample number	Museum number	Material/ Developmental stage	Collecting data	Length of LSN without posterior spines	Material status	Sequencing status	Days from capture to cyprid appearance	Y-larvae slide box (1–5) at NHMD[^]
Y-nauplius **Type L**	JA-2018-134	NHMD-1705141	LSN[*] Cyprid[¤]	26 Oct. 2018[#1]	290 µm			3	4
—‖—	Dish 200A (2018)	No voucher	LSN	5 Nov. 2018[#1]	280 µm				
—‖—	Dish 82C (2019)	No voucher	LSN	10 Jun. 2019[#1]	360 µm				
—‖—	Dish 133B (2019)	No voucher	LSN	11 Jun. 2019[#1]	360 µm				
—‖—	Dish 134A (2019)	No voucher	LSN	12 Jun. 2019[#1]	380 µm				
—‖—	JA-2019-118	NHMD-1705142	LSN[*] Cyprid[¤]	12 Jun. 2019[#1]	270 µm			4	5
—‖—	Dish 175C (2019)	No voucher	LSN	14 Jun. 2019[#1]	360 µm				
—‖—	JA-2019-369	NHMD-1705143	LSN[*] Cyprid[§]	19 Jun. 2019[#1]	270 µm		Cyprid sequenced	4	5
Y-nauplius **Type AB**	JA-2018-035	NHMD-1705144	LSN[*] Cyprid[¤]	19 Oct. 2018[#1]	220 µm (live ventral)			3	4
—‖—	JA-2018-018	NHMD-1705145	LSN[*] Cyprid[¤]	20 Oct. 2018[#1]	210 µm (live ventral)			1	4
—‖—	Dish 216B (2018)	No voucher	LSN	29 Oct. 2018[#1]	230 µm (live from ventral); 270 µm (live from lateral)				
—‖—	JA-2018-267	NHMD-1705146	LSN[*] Cyprid[¤]	30 Oct. 2018[#1]	230 µm (live from ventral)			4	4
—‖—	JA-2019-191	NHMD-1705147	LSN[*] Cyprid[¤]	13 Jun. 2019[#1]	230 µm (live from ventral)			6	5
—‖—	JA-2019-206	NHMD-1705148	LSN[*] Cyprid[§]	13 Jun. 2019[#1]	240 µm (live from ventral)		Cyprid sequenced	6	5
—‖—	Dish 204D (2019)	No voucher	LSN	29 Oct. 2018[#1]	230 µm (live from ventral)				
—‖—	JA-2019-220	NHMD-1705149	LSN[*] Cyprid[§]	16 Jun. 2019[#1]	210 µm (live from ventral)		Cyprid sequenced	4	5
—‖—	JA-2019-229	NHMD-1705150	LSN[*] Cyprid[¤]	16 Jun. 2019[#1]	260 µm (live from ventral)			4	5
—‖—	Specimen 107	NHMD-1705151	LSN[*]	25 Sep. 2005[#2]	250 µm (slide from ventral)				3
—‖—	Specimen 109	NHMD-1705152	LSN[*]	25 Sep. 2005[#2]	240 µm (slide from ventral)				3
—‖—	Slide 74	NHMD-1705153	LSN[*]	14–24 Oct. 2003[#2]	230 µm (slide from ventral)				1
Y-nauplius **Type Y**	JA-2018-097	No voucher	LSN[§]	18 Nov. 2018[#1]	400 µm		LSN sequenced		
—‖—	Dish 86C (2019)	No voucher	LSN	10 Jun. 2019[#1]	370 µm				
—‖—	JA-2019-166	No voucher	LSN[§]	10 Jun. 2019[#1]	370 µm		LSN sequenced		

Species/ Morphospecies	Sample number	Museum number	Material/ Developmental stage	Collecting data	Length of LSN without posterior spines	Material status	Sequencing status	Days from capture to cyprid appearance	Y-larvae slide box (1–5) at NHMD[^]
—ǁ—	JA-2019-352	No voucher	LSN[§]	15 Jun. 2019[#1]	360 µm		LSN sequenced		
—ǁ—	Slide DK 48	NHMD-1705154	LSN[*]	16–18 Jul. 1996[#2]	400 µm				2
—ǁ—	Specimen 118	NHMD-1705155	LSN[*]	25 Sep. 2005[#2]	405 µm				3
—ǁ—	Specimen 86	NHMD-1705156	LSN[*]	23 Sep. 2005[#2]	405 µm				3
—ǁ—	Specimen 110	NHMD-1705157	LSN[*]	26 Sep. 2005[#2]	410 µm				3
Y-nauplius **Type O***	JA-2018-078	NHMD-1705158	LSN[*] Cyprid[¤]	18 Oct. 2018[#1]	290 µm			7	4
—ǁ—	JA-2018-098	NHMD-1705159	LSN[*] Cyprid[§]	18 Oct. 2018[#1]	280 µm		Cyprid sequenced	8	4
—ǁ—	JA-2018-165	No voucher	LSN[§]	22 Oct. 2018[#1]	330 µm				
—ǁ—	Dish 49 (2018)	No voucher	LSN	18 Oct. 2018[#1]	230 µm				
—ǁ—	JA-2018-127	NHMD-1705160	LSN[*] Cyprid[¤]	18 Oct. 2018[#1]	290 µm			10	4
—ǁ—	JA-2018-131	NHMD-1705161	LSN[*] Cyprid[§]	18 Oct. 2018[#1]	300 µm		Cyprid sequenced	11	4
—ǁ—	Dish 112A (2018)	No voucher	LSN	29 Oct. 2018[#1]	280 µm				
—ǁ—	Dish 114A (2018)	No voucher	LSN	24 Oct. 2018[#1]	260 µm				
—ǁ—	JA-2018-198	No voucher	LSN[§]	24 Oct. 2018[#1]	280 µm		LSN sequenced		
—ǁ—	JA-2018-177	No voucher	LSN[§]	25 Oct. 2018[#1]	300 µm		LSN sequenced		
—ǁ—	Dish 160 – 2018	No voucher	LSN	27 Oct. 2018[#1]	260 µm				
—ǁ—	JA-2018-345	Uncatalogued	LSN[¤]	29 Oct. 2018[#1]	250 µm				
—ǁ—	JA-2018-349	No voucher	LSN[§]	30 Oct. 2018[#1]	250 µm				
—ǁ—	JA-2018-348	No voucher	LSN[§]	30 Oct. 2018[#1]	230 µm				
—ǁ—	JA-2018-300	No voucher	LSN[§]	30 Oct. 2018[#1]	240 µm				
—ǁ—	JA-2018-351	No voucher	LSN[§]	30 Oct. 2018[#1]	250 µm				
—ǁ—	JA-2019-230	NHMD-1705162	LSN[*] Cyprid[¤]	6 Jun. 2019[#1]	250 µm				5
—ǁ—	JA-2019-223	No voucher	LSN[*] Cyprid[§]	10 Jun. 2019[#1]	270 µm		Cyprid sequenced	10	5
—ǁ—	JA-2019-269	NHMD-1705163	LSN[*] Cyprid[§]	10 Jun. 2019[#1]	270 µm		Cyprid sequenced	11	5
—ǁ—	JA-2019-280	NHMD-1705164	LSN[*] Cyprid[§]	13 Jun. 2019[#1]	Not measured		Cyprid sequenced	8	5
—ǁ—	JA-2019-187	NHMD-1705165	LSN[*] Cyprid[¤]	13 Jun. 2019[#1]	260 µm			6	5
—ǁ—	JA-2019-349	No voucher	LSN[§]	15 Jun. 2019[#1]	250 µm				
—ǁ—	JA-2019-315	Uncatalogued	LSN[¤]	13 Jun. 2019[#1]	280 µm				
—ǁ—	JA-2019-316	Uncatalogued	LSN[¤]	13 Jun. 2019[#1]	270 µm				

Species/ Morphospecies	Sample number	Museum number	Material/ Developmental stage	Collecting data	Length of LSN without posterior spines	Material status	Sequencing status	Days from capture to cyprid appearance	Y-larvae slide box (1–5) at NHMD[^]
—‖—	JA-2019-350	No voucher	LSN[§]	13 Jun. 2019[#1]	280 µm		LSN sequenced		
—‖—	JA-2019-351	No voucher	LSN[§]	13 Jun. 2019[#1]	270 µm		LSN sequenced		
—‖—	JA-2019-354	No voucher	LSN[§]	16 Jun. 2019[#1]	290 µm		LSN sequenced		
—‖—	JA-2019-356	No voucher	LSN[§]	15 Jun. 2019[#1]	260 µm		LSN sequenced		
—‖—	JA-2019-358	No voucher	LSN[§]	15 Jun. 2019[#1]	260 µm		LSN sequenced		
—‖—	JA-2019-359	No voucher	LSN[§]	15 Jun. 2019[#1]	290 µm		LSN sequenced		
—‖—	JA-2019-361	No voucher	LSN[§]	12 Jun. 2019[#1]	280 µm		LSN sequenced		
—‖—	JA-2019-365	No voucher	LSN[§]	16 Jun. 2019[#1]	240 µm				
—‖—	JA-2019-364	No voucher	LSN[§]	16 Jun. 2019[#1]	260 µm				
—‖—	Dish 242D (2019)	No voucher	LSN	16 Jun. 2019[#1]	240 µm				
—‖—	JA-2019-310	Uncatalogued	LSN[¤]	12 Jun. 2019[#1]	300 µm				
—‖—	JA-2019-270	NHMD-1705171	LSN[*] Cyprid[¤]	12 Jun. 2019[#1]	240 µm			9	5
—‖—	JA-2019-172	No voucher	LSN[§]	11 Jun. 2019[#1]	240 µm				
—‖—	JA-2019-291	NHMD-1705174	LSN[*] Cyprid[§]	11 Jun. 2019[#1]	340 µm			9	5
—‖—	Dish 118A (2019)	No voucher	LSN	11 Jun. 2019[#1]	340 µm				
—‖—	Dish 79D (2019)	No voucher	LSN	10 Jun. 2019[#1]	250 µm				
—‖—	Dish 83B (2019)	No voucher	LSN	10 Jun. 2019[#1]	280 µm				
—‖—	Dish 91D (2019)	No voucher	LSN	10 Jun. 2019[#1]	250 µm				
—‖—	Dish 134B (2019)	No voucher	LSN	12 Jun. 2019[#1]	250 µm				
—‖—	Dish 169A (2019)	No voucher	LSN	14 Jun. 2019[#1]	250 µm				
—‖—	Dish 179B (2019)	No voucher	LSN	14 Jun. 2019[#1]	250 µm				
—‖—	Dish 179C (2019)	No voucher	LSN	14 Jun. 2019[#1]	260 µm				
—‖—	Dish 183B (2019)	No voucher	LSN	14 Jun. 2019[#1]	250 µm				
—‖—	Dish 199G (2019)	No voucher	LSN	12 Jun. 2019[#1]	240 µm				
—‖—	Dish 203I (2019)	No voucher	LSN	13 Jun. 2019[#1]	270 µm				
—‖—	Dish 203L (2019)	No voucher	LSN	13 Jun. 2019[#1]	250 µm				
—‖—	Dish 203N (2019)	No voucher	LSN	13 Jun. 2019[#1]	240 µm				
—‖—	Dish 204K (2019)	No voucher	LSN	13 Jun. 2019[#1]	250 µm				
—‖—	Dish 124I (2019)	No voucher	LSN	12 Jun. 2019[#1]	230 µm				
—‖—	Dish 124J (2019)	No voucher	LSN	12 Jun. 2019[#1]	240 µm				

Species/ Morphospecies	Sample number	Museum number	Material/ Developmental stage	Collecting data	Length of LSN without posterior spines	Material status	Sequencing status	Days from capture to cyprid appearance	Y-larvae slide box (1–5) at NHMD$^{\wedge}$
—‖—	Dish 124K (2019)	No voucher	LSN	12 Jun. 2019$^{\#1}$	240 µm				
—‖—	Dish 124L (2019)	No voucher	LSN	12 Jun. 2019$^{\#1}$	240 µm				
—‖—	Dish 201H (2019)	No voucher	LSN	12 Jun. 2019$^{\#1}$	240 µm				
—‖—	Dish 124J (2019)	No voucher	LSN	12 Jun. 2019$^{\#1}$	250 µm				
—‖—	Dish 171B (2019)	No voucher	LSN	14 Jun. 2019$^{\#1}$	290 µm				
—‖—	Dish 163A (2019)	No voucher	LSN	13 Jun. 2019$^{\#1}$	250 µm				
—‖—	Dish 94B (2019)	No voucher	LSN	12 Jun. 2019$^{\#1}$	250 µm				
—‖—	Dish 95B (2019)	No voucher	LSN	12 Jun. 2019$^{\#1}$	250 µm				
—‖—	Dish 95C (2019)	No voucher	LSN	12 Jun. 2019$^{\#1}$	310 µm				
—‖—	Dish 112C (2019)	No voucher	LSN	11 Jun. 2019$^{\#1}$	330 mm				
—‖—	Dish 112D (2019)	No voucher	LSN	11 Jun. 2019$^{\#1}$	330 µm				
—‖—	Dish 94A (2019)	No voucher	LSN	10 Jun. 2019$^{\#1}$	330 µm				
—‖—	Specimen 73	NHMD-1705175	LSN*	22 Sep. 2005$^{\#2}$	255 µm				3
—‖—	Specimen 131	NHMD-1705182	LSN*	26 Sep. 2005$^{\#2}$	255 µm				3
—‖—	Specimen 85	NHMD-1705183	LSN*	22 Sep. 2005$^{\#2}$	250 µm				3
—‖—	Slide 28	NHMD-1705184	LSN*	13 Oct. 2004$^{\#2}$	255 µm				1
—‖—	Specimen 74	NHMD-1705185	LSN*	22 Sep. 2005$^{\#2}$	250 µm				3
Y-nauplius **Type AF**	JA-2018-003	NHMD-1705186	LSN* Cyprid$^{\square}$	17 Oct. 2018$^{\#1}$	210 µm (live from lateral)			1	4
—‖—	JA-2018-058	NHMD-1705187	LSN* Cyprid$^{\square}$	18 Oct. 2018$^{\#1}$	260 µm (live from lateral)			6	4
—‖—	Dish 61 (2018)	No voucher	LSN	21 Oct. 2018$^{\#1}$	240 µm (live from lateral)				
—‖—	Dish 72 (2018)	No voucher	LSN	21 Oct. 2018$^{\#1}$	200 µm (live from lateral)				
—‖—	Dish 110 (2018)	No voucher	Nauplius	24 Oct. 2018$^{\#1}$	230 µm (live from lateral)				
—‖—	JA-2018-114	NHMD-1705188	LSN* Cyprid†	26 Oct. 2018$^{\#1}$	230 µm (live from lateral)			2	4
—‖—	JA-2018-250	NHMD-1705189	LSN* Cyprid$^{\square}$	30 Oct. 2018$^{\#1}$	240 µm (live from lateral)			4	4
—‖—	JA-2019-095	NHMD-1705190	LSN* Cyprid$^{\square}$	9 Jun. 2019$^{\#1}$	230 µm (live from lateral)			6	5
—‖—	Dish 56B (2019)	No voucher	LSN	10 Jun. 2019$^{\#1}$	Not measured				
—‖—	Dish 106B (2019)	No voucher	LSN	11 Jun. 2019$^{\#1}$	210 µm (live from lateral)				
—‖—	Dish 113A (2019)	No voucher	LSN	11 Jun. 2019$^{\#1}$	Not measured				

Species/ Morphospecies	Sample number	Museum number	Material/ Developmental stage	Collecting data	Length of LSN without posterior spines	Material status	Sequencing status	Days from capture to cyprid appearance	Y-larvae slide box (1–5) at NHMD[^]
—‖—	JA-2019-064	NHMD-1705191	LSN[¤]	11 Jun. 2019[#1]	230 µm (live from lateral)				
—‖—	JA-2019-108	NHMD-1705192	LSN[*] Cyprid[¤]	12 Jun. 2019[#1]	200 µm (live from lateral)			4	5
—‖—	JA-2019-111	NHMD-1705193	LSN[*] Cyprid[§]	12 Jun. 2019[#1]	210 µm (live from lateral)		Cyprid sequenced	4	5
—‖—	JA-2019-161	NHMD-1705194	LSN[*] Cyprid[§]	14 Jun. 2019[#1]	190 µm (live from lateral)		Cyprid sequenced	4	5
—‖—	Specimen 8	NHMD-1705195	LSN[*]	24 Sep. 2005[#2]	240 µm (slide from lateral)				3
—‖—	Slide DK 15	NHMD-1705196	LSN[*]	16–19 Jul. 1996[#2]	240 µm (slide from lateral)				2
Y-nauplius **Type N***	JA-2018-020	NHMD-1705197	LSN[*] Cyprid[¤]	16 Oct. 2018[#1]	220 µm			6	4
—‖—	JA-2018-022	NHMD-1705198	LSN[*] Cyprid[†]	19 Oct. 2018[#1]	240 µm			3	4
—‖—	JA-2018-023	NHMD-1705199	LSN[*] Cyprid[¤]	20 Oct. 2018[#1]	240 µm			2	4
—‖—	JA-2018-036	NHMD-1705200	LSN[*] Cyprid[¤]	21 Oct. 2018[#1]	220 µm			2	4
—‖—	JA-2018-167	No voucher	LSN[§]	20 Oct. 2018[#1]	240 µm				
—‖—	JA-2018-163	No voucher	LSN[§]	26 Oct. 2018[#1]	210 µm		LSN sequenced		
—‖—	JA-2018-282	NHMD-1705201	LSN[*] Cyprid[¤]	29 Oct. 2018[#1]	240 µm			6	4
—‖—	JA-2018-285	NHMD-1705202	LSN[*] Cyprid[¤]	29 Oct. 2018[#1]	230 µm			6	4
—‖—	JA-2018-299	No voucher	LSN[§]	30 Oct. 2018[#1]	230 µm		LSN sequenced		
—‖—	JA-2018-266	NHMD-1705203	LSN[*] Cyprid[¤]	30 Oct. 2018[#1]	230 µm			4	4
—‖—	JA-2018-316	No voucher	LSN[§]	31 Oct. 2018[#1]	230 µm		LSN sequenced		
—‖—	JA-2018-355	Uncatalogued	LSN[¤]	31 Oct. 2018[#1]	220 µm				
—‖—	JA-2018-216	NHMD-1705204	LSN[*] Cyprid[¤]	28 Oct. 2018[#1]	230 µm			6	4
—‖—	Dish 171D (2018)	No voucher	LSN	28 Oct. 2018[#1]	250 µm				
—‖—	Dish 37B (2019)	No voucher	LSN	9 Jun. 2019[#1]	240 µm				
—‖—	Dish 93A (2019)	No voucher	LSN	10 Jun. 2019[#1]	210 µm				
—‖—	Dish 201F (2019)	No voucher	LSN	12 Jun. 2019[#1]	230 µm				
—‖—	Dish 124J (2019)	No voucher	LSN	11 Jun. 2019[#1]	230 µm				
—‖—	JA-2019-368	No voucher	LSN[§]	16 Jun. 2019[#1]	200 µm		LSN sequenced		
—‖—	Specimen 108	NHMD-1705205	LSN[*]	25 Sep. 2005[#2]	235 µm				3
Y-nauplius **Type AP**	Slide 25	NHMD-1705206	LSN[*]	13–21 Oct. 2004[#2]	350 µm (slide from lateral)				3

Species/ Morphospecies	Sample number	Museum number	Material/ Developmental stage	Collecting data	Length of LSN without posterior spines	Material status	Sequencing status	Days from capture to cyprid appearance	Y-larvae slide box (1–5) at NHMD[^]
Y-nauplius **Type AL**	JA-2018-006	NHMD-1705207	LSN[*] Cyprid[¤]	18 Oct. 2018[#1]	340 µm (live from ventral)			1	4
—‖—	JA-2019-256	No voucher	LSN[§]	20 Jun. 2019[#1]	320 µm (live from ventral)		LSN sequenced		
—‖—	Dish 2 (2019)	No voucher	LSN	9 Jun. 2019[#1]	320 µm (live from ventral)				
Y-nauplius **Type AJ**	Dish 111A (2018)	No voucher	LSN	24 Oct. 2018[#1]	360 µm				
—‖—	JA-2019-314	Uncatalogued	LSN[¤]	14 Jun. 2019[#1]	360 µm				
—‖—	JA-2019-317	Uncatalogued	LSN[¤]	13 Jun. 2019[#1]	350 µm				
—‖—	JA-2019-209	NHMD-1705208	LSN[†]	9 Jun. 2019[#1]	360 µm				
Y-nauplius **Type AK**	JA-2019-313	Uncatalogued	LSN[¤]	14 Jun. 2019[#1]	350 µm (live from ventral)				
—‖—	JA-2019-295	NHMD-1705209	LSN[*] Cyprid[¤]	14 Jun. 2019[#1]	350 µm (live from ventral), 360 (live from lateral)			8	5
—‖—	Dish 83 (2019)	No voucher	LSN	10 Jun. 2019[#1]	330 µm (live from ventral)				
—‖—	Dish 83C (2019)	No voucher	LSN	10 Jun. 2019[#1]	330 µm (live from ventral)				
—‖—	Specimen 130	NHMD-1705210	LSN[*]	23 Sep. 2005[#2]	350 µm (slide from ventral)				3
Y-nauplius **Type AO**	Slide 61	NHMD-1705211	LSN[*]	15 Oct. 2003[#2]	375 µm				1
Y-nauplius **Type AM**	JA-2019-312	No voucher	LSN[§]	14 Jun. 2019[#1]	420 µm		LSN sequenced		
Y-nauplius **Type AN**	Specimen 113	NHMD-1705212	LSN[*]	25 Sep. 2005[#2]	340 µm				3
—‖—	Specimen 41	NHMD-1705213	LSN[*]	22 Sep. 2005[#2]	325 µm				3
—‖—	Specimen 126	NHMD-1705214	LSN[*]	25 Sep. 2005[#2]	320 µm				3
—‖—	Specimen 105	NHMD-1705215	LSN[*]	24 Sep. 2005[#2]	320 µm				3