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A New Record of *Hydroptila cruciata* Ulmer (Trichoptera, Hydroptilidae) in Southern Oman with Notes On Its Larval Biology

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سجل جديد لحشرة هيدروبتلا كروشياتا ألمر (ترايكوبترا هيدروبتيليدا) في جنوب عُمان مع ملاحظة بيولوجية يرقاتها

رجنالد فيكتور

خلاصة : تم وللمرة الأولى في سلطنة عُمان جمع الطورين اليرقيين الرابع والخامس لهيدروبتيليد ترايكوبترا (*Hydroptila cruciata* اولمر ١٩١٢) . يبني الطور اليرقي الخامس مع الطحالب الخيطية وكراً يشبه الحقيبة . هذا البحث يقدم معلومات عن خصائص البيئة التي يستوطنها هذا النوع مع التعريف ببيولوجية اليرقة

ABSTRACT: Fourth and fifth instar larvae of a hydroptilid trichopteran, *Hydroptila cruciata* Ulmer 1912 were collected in the Sultanate of Oman for the first time. The fifth instar larva constructs a purse-case with filamentous algae. Notes on the habitat characteristics and the larval biology of this species are given.

The biology and ecology of caddisflies (Insecta, Trichoptera) in the Sultanate of Oman are poorly known. About 20 adult trichopteran taxa have been recorded in the Arabian Peninsula of which, only seven are known to occur in Oman (Malicky, 1986, 1989). Family Hydroptilidae is represented by five species in Yemen and only one of these, *Hydroptila adana Mosely* 1948 has been previously recorded in northern Oman (Malicky, 1989). During a faunal survey of freshwater springs (= *ayns*) in southern Oman, free-living and case-dwelling larvae of a hydroptilid species were collected. This paper considers the identity of this interesting species that uses filamentous algae for case building and provides notes on its larval biology.

Study Area

Hydroptilid larvae were collected from Ayn Tobruk, a permanent spring in the Wadi Feedhlayt drainage system, eastern Jabal Qara, Dhofar Governorate, southern Oman (UTM grid reference 2156 18927, Salalah Sheet NE 40-90, Oman 1: 100000). It is located at an altitude of at about 110 m above sea level, 8 km inland from Khawr Sawli on the coastal plain, 40 km east of Salalah. The spring originates from underneath a large boulder and forms a short riffle interrupted by a concrete tank (area 2 x 2 m; depth 1.5 m). The tank overflows to form a shallow pool area, approximately 250 m long, 1-10 m wide and 20-30 cm deep. Although the flow velocity is very low, the pool overflows as a small cascade and continues as a narrow riffle for another 100 m before disappearing into the ground. The pool substrates are detritus, silt and sand over large rocks. The upstream pool area near the concrete tank, where the invertebrates were sampled had extensive vegetation cover, mostly *Polygonum senegalense* Meisn. and the water fern, *Ceratopteris thalictroides* (L) Brogn. The submerged floras were filamentous Cyanophyceae, Chlorophyceae, especially *Spirogyra* sp. and *Chara denudata* A. Braun. The pool is eutrophic with patches of floating algal mats on the entire surface. It is a watering station for cattle and cattle droppings are ubiquitous, even in the pool. Table 1 gives the physical and chemical characteristics of water in the study habitat for two sampling dates.

TABLE 1

Physical and chemical characteristics of Ayn Tobruk in August 1992 and January 1993; values given are averages or ranges determined from two random samples collected on each sampling date.

	3 August 1992	11 January 1993
Temperature		
(°C) Air	30.5	26.0-27.5
(°C) Water	28.0	27.0-29.0
pH	8.0-8.2	7.8-7.9
Conductivity (μs)	647	675
Alkalinity (mg CaCo3 l^{-1})	110	190
Chloride (mg l^{-1})	42	43
Sulfate (mg l^{-1})	7.1	12.5
Fluoride (mg l^{-1})	0.1	0.1
Nitrate-N (mg l^{-1})	3.6	3.5
Phosphate (ppm)	<0.2	<0.2
Hardness (mg l^{-1})	170	210
Calcium (mg l^{-1})	46	63
Magnesium (mg l^{-1})	16	13
Sodium (mg l^{-1})	15	21
Potassium (mg l^{-1})	1.0	1.0
Soluble Iron (μg l^{-1})	<50	<50
Soluble Manganese (μg l^{-1})	<50	<50
Total Solids (μg l^{-1})	220	275
Dissolved Oxygen (mg l^{-1})	3.9-5.2	4.2-5.6

Materials and Methods

Qualitative kick-samples of the substratum for benthic invertebrates were collected on four occasions 22 March, 9 April, August, 1992 and January 1993. Both free-living and case-dwelling larvae were sorted from the samples and preserved in 70% ethanol. Fifth instar larvae were extracted from the case and temporarily mounted in glycerin-water mixture for microscopic study. Cases were also teased out in glycerin-water mixture to identify the algae and associated organisms. Gut contents of larvae were examined for identifying food items. Photomicrographs were taken using Olympus SZH10 and QM-10AK research microscopes at appropriate magnifications and the Scanning Electron Microscope used was a Jeol JSM 840A.

Reference collection of larvae used in this study, including one pupa and one winged pre-adult within their cases are deposited in the Instituut voor Systematiek en Populatie Biologie (Zoölogisch Museum), Universiteit van Amsterdam, The Netherlands. Some duplicate larvae are also deposited in the Natural History Museum, Ministry of Heritage and Culture, Muscat, Sultanate of Oman.

Results and Discussion

Figures 1 and 2 show the fourth and fifth instar larvae. The standard taxonomic texts for the identification of larval Trichoptera showed that these larvae belonged to the family Hydroptilidae (Wiggins, 1996 a,b). The sclerotized plates on all three thoracic pronota of the fifth instar and the absence of abdominal gills are especially diagnostic of hydroptilids. Although adults of this species were not collected during this study, the morphology of fifth instar larvae and their cases made of filamentous algae in concentric circles were adequate to identify this species as *Hydroptila cruciata* Ulmer 1912 (Barnard, 1934; Botosaneanu and Giudicelli, 1981).

Malicky (1986) treats *Hydroptila hirra* Mosely 1948 as a junior synonym of *H. cruciata*, thus extending its distribution range to Western Arabia, Palestine and all of Africa. Barnard (1934) described *Hydroptila capensis* as a new species from South Africa and his illustration of the fifth instar showed that specimens collected from Oman (Figure 2)

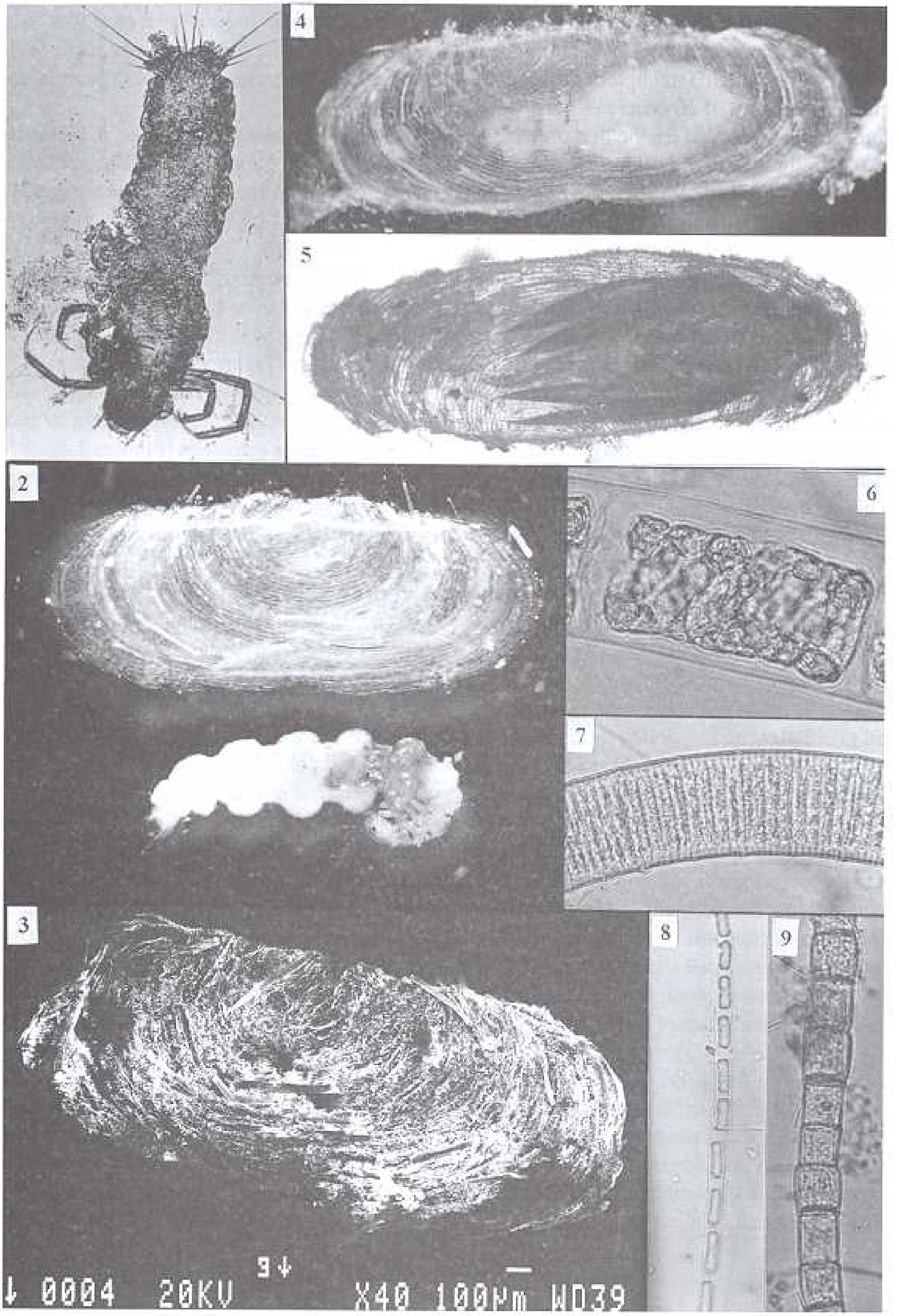

Figure 1. Free-living fourth instar larva (x 40).
Figure 2. The case constructed by a fifth instar larva using filamentous algae and the fifth instar larva that occupied this case (x 25).
Figure 3. The scanning electron micrograph of the larval case.
Figure 4. The case with the pupa (x 30).
Figure 5. The case with the winged pre-adult before emergence (x 30).
Figure 6. A part of Spirogyra filament showing cell inclusions (x 400).
Figure 7. A part of Lyngbya filament (x 400).
Figure 8. An unidentified blue-green filament taken from a case (x 200).
Figure 9. An unidentified filamentous alga taken from a case (x 100).

belonged to the same species. *H. capensis* also lived "amongst masses of *Spirogyra*", the case was "most beautifully constructed with filaments of *Spirogyra*" and the filaments were arranged "more or less concentrically" (Barnard, 1934). Taxonomic studies on Arabian Trichoptera do not refer to Barnard's (1934) monograph and there is no doubt that *H. capensis* is another synonym of *H. cruciata*.

H. cruciata has been recorded for the first time in Oman. Since it has been earlier recorded in Yemen and in western Saudi Arabia, its contiguous distribution extending to Southern Oman is not surprising. Botosaneanu and Giudicelli (1981) considered this species as a relict inhabitant of permanent streams and streamlets in semi-desert environments and Ayn Tobruk where this species was collected is one such environment. Five other streams at lower altitudes were sampled in southern Oman at the same time but this species was not recorded.

Very little is known about the larval biology of *H. cruciata*. The hydroptilid life cycle includes four free-living instars and the fifth and final instar which lives in a case. The free-living and case-dwelling instars are morphologically different exhibiting larval heteromorphosis or hypermetamorphosis (Wiggins, 1996 a). This is certainly true for *H. cruciata* (Figures 1,2) and the metamorphosis is completed within the case (Figures 4,5).

The length of case is helpful in assessing the adult size of this species. The mean length / height/ width (standard deviation (n = 10) were, 4.0±0.2, 1.5±0.2 and 1.0±0.1 mm respectively. The length ratio of larva to case ranged from 0.82 - 0.87. The shape of the case resembled the carapace of herpetocypridine ostracods (Figures 2-5). Most cases with larvae inside had a small slit in the end nearer to the head. Some cases were closed along all margins. Empty cases were always open along the entire length of one margin. Cases with larvae were composed of live green or blue-green filaments with intact cells and cell inclusions (Figures 6,7), while all cases without larvae were made of dead and decomposing or empty filaments.

The main filamentous components of cases were the blue-green alga, *Lyngbya* sp. and the green alga, *Spirogyra sp.* (Figures 6,7). The mean width of *Lyngbya* filaments (n = 41) was 0.036±0.004 mm, while the mean width of *Spirogyra* filaments (n = 24) was 0.045±0.002 mm. There was no significant difference in the filament widths of the two main species used in case construction (unpaired t- test, P< 0,05). Most cases examined were made of both *Lyngbya* and *Spirogyra* and only a few were made with either of the two taxa. There were also a few other species of filamentous blue-green and green algae incorporated in cases (Figures 8,9), but these were very few in number. Cases with larvae had live assemblages of organisms composed of bacteria, unicellular and colonial blue algae, several species of diatoms, attached protozoa and nematodes. Dead organic and inorganic particulate matter was also abundant on the surface of these cases.

Case building appears to be a complex process involving the gluing of filaments in compact concentric bundles to form a purse. The mechanism of construction by *H. cruciata* is yet to be documented. There was no correlation between the size of larvae and the thickness of filaments used in construction. The smallest fifth instar larva could use the thickest filament. Filament selection was not specific and it was probably determined by availability rather than by the type.

Apart from using filamentous algae for case construction, *H. cruciata* has been known to construct a mineral cocoon, resembling that of glossomatid pupa, composed of fine and coarse sand prior to pupation. Mineral cocoons were not seen in this study. The kick sampling of the substratum and sieving methods used for sorting would have destroyed such cocoons.

Purse-cases made by two other genera, *Agraylea* and *Metrichia* showed strong similarities to cases built by *H. cruciata*, but the morphology of fifth instar larvae in these genera are very different. Unrelated hydroptilid genera seem to use filamentous algae for building cases. Gut contents of the free-living fourth and case-dwelling fifth instar larvae of *H. cruciata* showed that the former (n = 2) predominantly contained diatoms and unicellular green algae, while the latter (n = 2) was chlorophyll containing liquid with unrecognizable organic particles. Some hydroptilids feed on the cellular contents of filamentous algae and the use of same material for case building could have evolved independently in unrelated taxa.

Information on the physical and chemical environment of Arabian trichopteran larvae is non-existent. These data are provided for two months, when the larval abundance of *H. cruciata* was high. Larvae were collected in a stream-pool habitat where, there was no measurable velocity of flow, a critical factor influencing the occurrence of net-spinning Trichoptera. Spinning long filaments in concentric rings to form a complex case is perhaps difficult in fast flowing erosion habitats.

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