Région orientale (*Tabanus* : *rufiventris* FAB., *striatus* FAB. et *Haematopota lunulata* MACQ.). On peut les trouver dans les zones limitrophes de la Région paléarctique.

D'autres espèces sont holarctiques : *Chrysops nigripes* ZETT. ; *Hybomitra aequetincta* BECK., *arpadi* SZIL., *astuta* HINE, *lapponica* WALK., *lurida* FALLEN, *montana* MEIGEN, *nitidifrons* SZILADY, *sexfasciata* HINE (OLSUFJEV, 1971).

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ADULT, LARVA AND BIOLOGY OF **Conostigmus quadratogenalis** DESSART & COOPER, sp.n., (Hym. Ceraphronoidea), PARASITE of **Boreus** (Mecoptera) in California*

par Kenneth W. COOPER** and Paul DESSART***

ABSTRACT

Description is given of both sexes of *Conostigmus quadratogenalis* DESSART & COOPER, sp., n. and its last instar larva, a parasitoid of the southern Californian *Boreus notoperates* COOPER, 1972. It is the first known ceraphronoid with a mecopteran host, and its last instar larva has the unique distinction (as far as now known) among ceraphronoids of having sharply toothed mandibular blades. Evidence is given that *Conostigmus quadratogenalis* sp. n. is likely endophagic in its early instars ; it thus would appear to be the first known endoparasitoid among the *Megaspilidae*. Nevertheless, endoparasitism is known in the sister family *Ceraphronidae* (cf. PSCHORN - WALCHER, 1956). Development from the final instar to the imago is described, and interrelations with its host's peculiar life cycle are discussed.

INTRODUCTION

The *Megaspilidae*, so far as known, are ectophagic parasitoids that range over a wide variety of primary hosts, including Homoptera (coccids), Neuroptera (hemerobiids, chrysopids, and coniopterygids), Diptera (cecidomyiids, syrphids, chloropids, chamaemyiids, and muscids), and especially Hymenoptera (aphidiids, braconids, chalcids, encyrtids, and cynipids). By their primary

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attack on parasitoid Hymenoptera, many species are found chiefly as secondary parasites of agriculturally significant insects, both injurious and beneficial ; thus megaspilids have been reared from aphids, coccids, chermids, psyllids and coccinellids in which the true primary host is to be found.

The purpose of this article is to describe a remarkable new species of *Conostigmus* which is a parasitoid of *Boreus*. It thus adds still another order of insects to the range of known primary hosts, not only of megaspilids, but of the superfamily *Ceraphronoidea,* namely the *Mecoptera*. We also present a description of its last instar larva, and such facts of the life history as are now known. Unlike some megaspilids that are polyphagic, this species is probably restricted to *Boreus notoperates* COOPER, 1972, and so its probable adaptations to life with *Boreus* are touched upon.

Our authorship is partially divided in responsibility. DESSART made the preparations of the adult specimens, cast the description (corroborated by both of us) in the uniform style that marks his monographic studies of *Ceraphronoidea,* and made the tabulated measurements so necessary for comparative studies of these minute wasps. COOPER prepared the larval dissections and description, and is responsible for the observations on life history and their implications.

DESCRIPTION

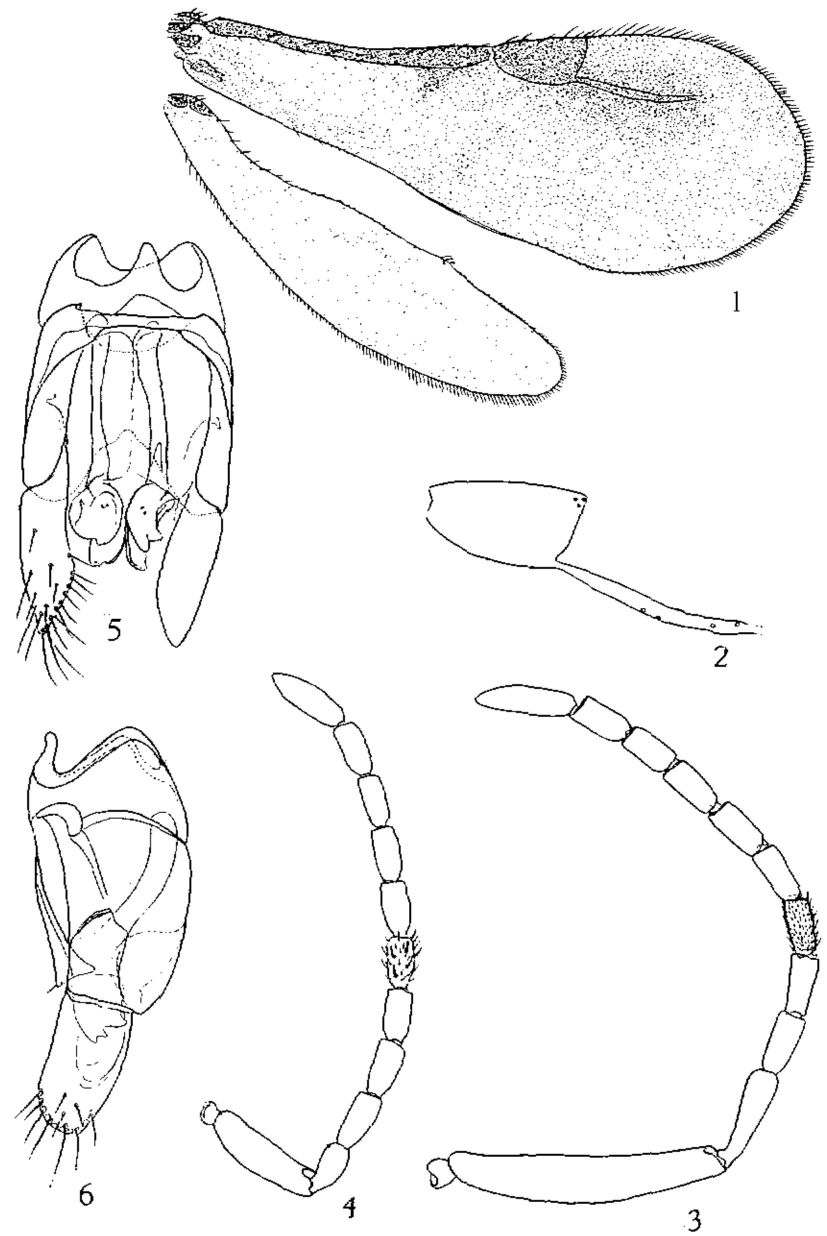
Conostigmus quadratogenalis sp. n. DESSART & COOPER

FEMALE HOLOTYPE

Body blackish-brown ; supraclypeal depression and lower genae somewhat lighter ; mandibles clear brown with the apical teeth darker, reddish ; antennae and legs yellowish brown, the coxae darker ; wings noticeably smoky, clouded ; a basally directed, oblique darkening in the membrane marks the junction of the basal vein at the costal margin of the forewing ; two long hyaline creases in the membrane, intrepreted as traces of media and anal veins by MASNER & DESSART (1967), of which the proximal end of media bends anteriorly to unite with the proximal end of the basal vein.

H e a d (Figs. 7-10) : Very peculiar for its slightly transverse, subquadrate form brought about by broadening and truncation of the lower face. Integument alutaceous to very finely coriaceous, with short, sparse, erect pubescence. Vertex regularly rounded, consequently without a definite preoccipital lunule ; preoccipital furrouw difficult to discern, obsolete ; face with a very weak longitudinal, median line (not a true furrow) ; supraclypeal depression weak, with a small median, triangular prominence and a pair of paramedian, shallow concavities above the antennal sockets ; median fovea rather broader than deep. In frontal view (fig. 7), the ocellar triangle lies well beneath the upper margin of head, and the eyes are not bulging and barely reach the side of head. Eyes narrower than usual, with very short, sparse hairs : 0.24 mm long × 0.16 mm wide ; minimal interocular facial space 0.30 mm (actually 56 % of head breadth) ; hind ocelli with the customary shining lunule hardly discernible ; postocellar line (POL) /lateral ocelar line (LOL) / ocular-ocellar line (OOL) = 0.08 mm/ 0.06 mm/0.10 mm. Temples in dorsal view with a direct breadth (ignoring convexity) of 0.19 mm, reducing to ca. 0.15 mm in lateral view because of obliquity of surface. Width of proboscidial fossa (namely, distance between external articulations of mandibles) ca. 0.4 mm (actually 82 % breadth of head). Antennae slender (fig. 3), the last flagellomeres barely broader (38 µ) than the median and basal ones (35 µ) ; scape slender (length/breadth = 5.85), longer (0.34 mm) than the three following joints together (0.30 mm) ; pedicel clearly larger than first flagellomere, ratio 1.75/1.0 ; flagellomeres of very similar dimensions, except that IX is conspicuously shorter than VIII and X (see table). Antennae notably shorter (1.2 mm) than the body (2.0 mm).

M e s o s o m a : Mesoscutum with short pubescence, finely reticulate, coraceous or finely shagreened ; scutellum more shining, with finer micro-sculpture ; parapsidal furrows sigmoid, converging to and reaching the base of the median, longitudinal furrow ; median furrow weakly foveolate, parapsidal furrows more strongly, elongately foveolate ; paramedian supplementary dashes in slight carinae, parapsidal dashes in edges. Axillo-scutellar furrows finely foveolate, meeting side by side at the posterior transverse mesoscutal furrow (hence no common median fovea). Scutellum clearly convex, margined peripherally but without lateral carinae. Metanotum represented by a foveolated furrow (medially overhung by the apex of the scutellum) which, before reaching the axillae, seems to stop abruptly. Propodeum sloping, finely reticulated, with a median longitudinal structure that ap-



PL. 1. — *Conostigmus quadratogenalis* DESSART & COOPER, sp. n. 1.- Holotype ♀, right wings (x 60). 2.- Id., stigma and radial vein (x 104). 3.- Id., right antenna (x 104). 4.- Allotype ♂, right antenna (x 104). 5.- Id., genitalia, ventral aspect (x 285). 6.- Id., genitalia, left lateral aspect (x 285).

pears as a fine, double carina in the holotype, but in other specimens is hardly visible, obsolete. Sides of the pronotum, prepectus, mesopleuron and metapleuron finely coriaceous ; Y-shaped furrow of the pronotum not very deep, the sclerite itself slightly concave ; mesopleuron devoid of a sternaulus, separated from the metapleuron by a fine furrow.

W i n g s (figs. 1, 2) : Stigma rather long (length/breadth = 1.9) ; radial vein nearly 1.4 times as long as the stigma.

L e g s : No special features.

M e t a s o m a : Basal fan of carinae tripartite ; the median portion with strong carinae, the lateral fans with much slighter carinae which at certain angles of observation become invisible, the lateral thirds then seem rather smooth and shining. Anterolaterally, the large tergite (first gastral tergite) is shagreened and pubescent as usual, slightly depressed, but not rounded ; hind margin of the first gastral tergite and following tergites finely alutaceous. Gastrocoeli at the hind margin of the basal fan.

MALE ALLOTYPE

Differs from the female chiefly by its antennae (fig. 4), genitalia (figs. 5, 6), more globose face, supraclypeal area not lighter than ground color of head, ground color of body generally darker, and by its much smaller size 1.4 mm (♀ = 2.0 mm) (See Table 1). Scape (159 μ), longer than the two following joints together (146 μ) ; pedicel (70 μ) slightly shorter than the third joint (76 μ) ; third joint longer than all other flagellomeres, except the apical one (110 μ).

VARIATION AMONG SPECIMENS

The six female specimens range in total body length from 1.6-2.0 mm, or (more exactly determinable) in mesosomal lengths from 0.51-0.70 mm, with the holotype being largest of all. The somewhat lighter coloration of the supraclypeal depression and genae is clear in four females, there is no *genal* lightening of ground color in one, and in the last female there is *neither* supraclypeal nor genal paleness. All three males are smaller than the smallest female, body sizes and mesosomal lengths from 1.1-1.4 mm and 0.42-0.48 mm respectively ; the allotype is the largest male.

Table 1.

Standard measurements (in µ) and proportions of the types

1) ♂ allotype (74a15; 7403/291)
2) ♀ holotype (73k15; 7402/261)

Antennae	I	II	III	IV	V	VI	VII	VIII	IX	X	XI
1) Length in µ	159	70	76	72	70	70	70	70	70	70	110
Width in µ	48	38	35	38	35	35	33	31	31	33	33
Length in %	100	44	48	45	44	44	44	44	44	44	69
Width in %	30	24	22	24	22	22	21	19	19	21	21
Length/width	3,31	1,84	2,17	1,89	2,00	2,00	2,12	2,26	2,26	2,12	3,33
2) Length in µ	345	138	79	79	72	72	79	79	70	79	128
Width in µ	59	38	35	35	35	35	35	35	38	38	38
Length in %	100	40	23	23	21	21	23	23	20	23	37
Width in %	17	11	10	10	10	10	10	10	11	11	11
Length/width	5,85	3,63	2,26	2,26	2,06	2,06	2,26	2,26	1,84	2,08	3,36

		1)	2)
Body	Total length	1 380	2 035
Antennae	Total length	907	1 220
Head	Length	255	395
	Width	390	525
	Height	350-320	535-480
Mesosoma	Length	480	695
	Width	320	455
	Height	335	440
Mesoscutum	Length	135	255
Medial axillary length + scutellum		175	255
Scutellum	Length	165	240
	Total width	225	270
	Conv. part width	160	200
Metanotum + dorsal part of propodeum		40	60
Metanotum + total length of propodeum		70	120
Metasoma	Length	645	1 005
	Width	335	605
	Height	270	± 335
Metasomatic collar	Width	165	230
Basal grooved area	Length	110	200
	Width	190	295
Large tergite	Length	335	605
Fore wing	Length	1 020	1 455
	Width	370	505
Radius	Length	168	276
Stigma	Length	150	200
	Width	74	104
	Length/width	2.03	1.92
Radius/stigma	Length/length	1.25	1.38
Subapical marginal cilia	Length	-	17
Hind wing	Length	805	1 100
	Width	175	250
Proximal marginal cilia	Length	-	38
Medial marginal cilia	Length	-	15
Distal marginal cilia	Length	-	31

The venational traces in the membrane of the forewing of two females (73 l 25 and 74 d 16) are fairly complete, appearing similar to those figured by MASNER & DESSART (1967, fig. 43) for *Conostigmus sp.*

MATERIAL

The type series includes the female holotype, five female paratypes, the male allotype and two male paratypes. The nine adults matured from eleven fully-fed larvae, of an original lot of 17 such larvae or hosts taken on August 15 and 22, 1973, from cells of last instar larvae of *Boreus notoperates* COOPER, 1972. All were collected by Ruth and K. W. COOPER at the type locality of the host, namely : Coldwater Canyon, 1219 m. altitude, Mt. San Jacinto (*ca* 33.7°N by 116.6°W), Riverside County, California.

DISPOSITION OF TYPES

The specimens have been deposited as follow : female holotype (73 k 15 = N°7402/261), male allotype (74 a 15 = N°7403/291), and larval paratype (73 f 13-1), U.S. National Museum, Washington, D.C. ; four female paratypes (73 l 19 ; 73 l 25 ; 74 d 15 = N°7405/061 ; and 74 e 20), one male paratype 74 d 17 = N° 7405/281), and larval paratype (74 f 13-2), Institut royal des Sciences naturelles de Belgique, Bruxelles ; one female paratype (73 j 30) and one male paratype (74 f 18), Museum of Comparative Zoology, Harvard University, Cambridge, Mass.

ETYMOLOGY

From Latin : *quadratus,* square ; *genalis,* pertaining to *genae* or cheeks.

COMPARATIVE

The trivial name refers to the peculiar crabronid-like, squared-off lower face, in full face view (fig. 7), giving a from of head strikingly different from all other American species of *Conostigmus* described from north of the Mexican border.

Types of fourteen of the fifteen species described by ASHMEAD and now placed in *Conostigmus* (see MUESEBECK 1973 for references to all relevant species) were examined at the U.S. National

Museum (by K.W.C.), as well as those of *C. ater* FOUTS, 1926, *C. crawfordi* (MANN, 1920) (a brachypterous species) and *C. zaglouli* KAMAL, 1926. None resembles *C. quadratogenalis* sp. n. The descriptions of KIEFFER's seven species from the United States, of PROVANCHER's two, of ASHMEAD's *C. hyalinipennis* (ASHMEAD, 1887), of *C. orcasensis* (BRUES, 1910), *C. timberlakei* KAMAL, 1926, and *C. pulchellus* WITTAKER, 1930, establish all of them as different from *C. quadratogenalis* sp. n. by notably significant structural, dimensional (especially antennal) and other characters, in addition to the lack in all of them of the distinctive physiognomy of *C. quadratogenalis* sp. n.

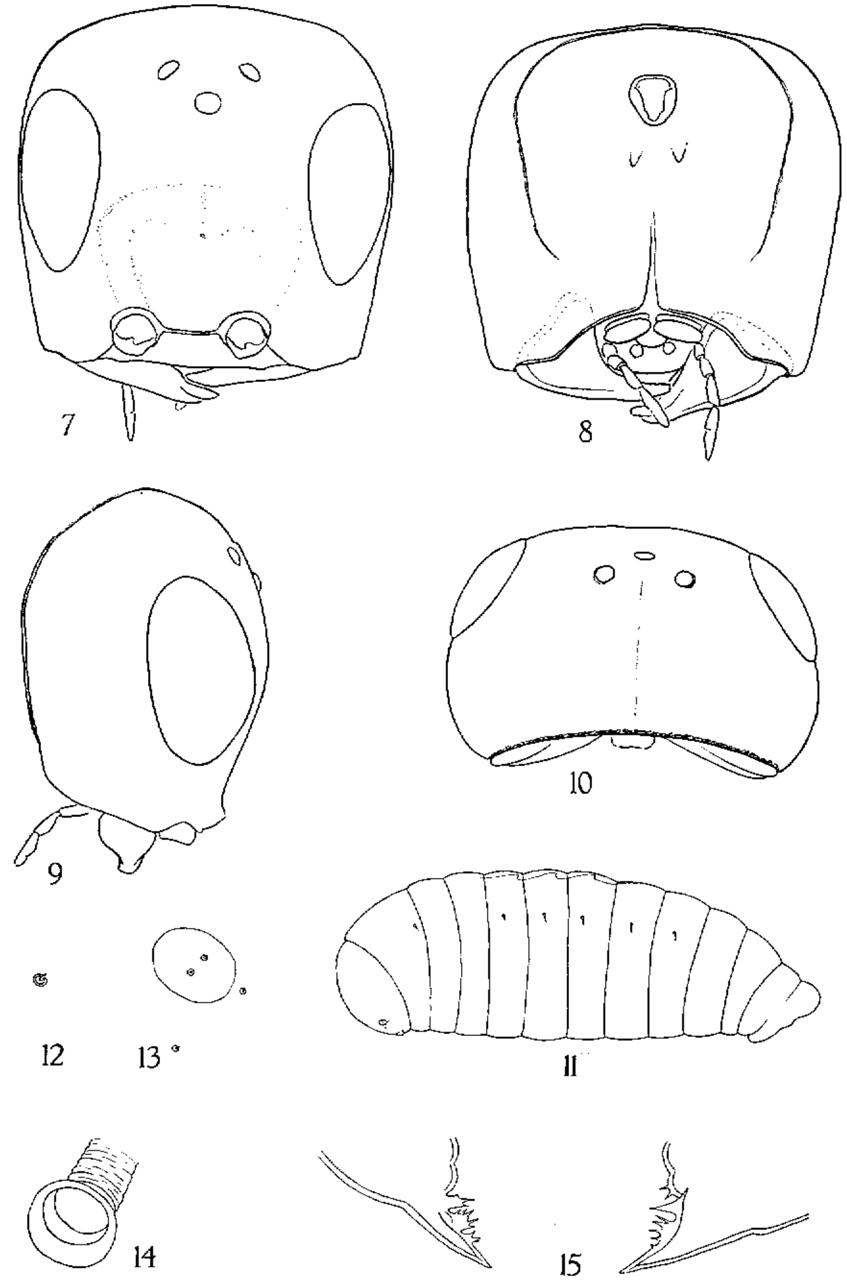
Interestingly, BRUES (1940, fig. 5) has portrayed a specimen from Oligocene Baltic amber as a male of *Conostigmus* † *succinalis* BRUES, 1940 as having a peculiarly quadrate head which, apart from the very large eyes and pronounced median furrow, is suggestive of that of *C. quadratogenalis* sp. n. We have examined the specimen from which that figure was drawn*. The shape of the head is in fact roughly globose, as in most *Conostigmus*, and is not at all quadrate or similar to that of *C. quadratogenalis* sp. n. So far as now known, the head shape of *C. quadratogenalis* sp. n. is unique within the genus.

DESCRIPTION OF LARVA (figs. 11-15)

The last instar larva is described from the external morphology of three specimens that had already advanced to the state of an early pharate pupa (see HINTON, 1973).

Body (fig. 11) creamy-white, opaque ; 12-segmented ; from 2-3 mm long, *ca.* 0.5-0.6 mm in girth ; narrowing gently in apical third. Integument transparent, smooth, not papillate. Relative proportions of head, thorax and abdomen : 1/2.5/7.6. Antennae

* The specimen in question is mounted on a slide bearing two labels. The leftmost reads : Phys. Oek. Ges./No. 4202/IV No. 83 ; the rightmost : Drawing no. 38. The disposition of antennae, wings and legs corresponds with that of BRUES' figure 5, and there can be no doubt that this is the specimen that BRUES represents, although his figure is inexact in a number of details in addition to that of the head. The specimen tray containing the slide contains two handscript labels : the first, which is crossed out, states « *Conostigmus succinalis* Brues ♂ » ; the second, on green paper, bears the notation « *Ceraphron* or *Megaspilus* # 38 ».



PL. 2. — *Conostigmus quadratogenalis* DESSART & COOPER, sp. n. 7.- Paratype ♀, head, face view (x 104). 8.- Id., posterior aspect (x 104). 9.- Id., right lateral aspect (x 104). 10.- Id., dorsal aspect (x 104). 11.- Larval paratypes, left lateral aspect (composite drawing from larvae 74 f 13-1 and 74 f 13-2) ; separation of pupal from larval integument visible mid-dorsally. (x 225). 12.- Id., one peg-organ (x 660). 13.- Id., left antennal « sclerite » with two peg-organs centrally, one to rear, one ventrally (x 275). 14 - Id., prothoracic spirale, slightly oblique view into aperture (x 770). 15.- Id., Mandibles, distal ends (x 770). See text.

(figs 11-13) in oral third of head, slightly convex, broadly elliptical (diameters *ca.* 45 µ × 36 µ) ; in face view, centers *ca.* 180 µ apart, long axis of each nearly parallel to body axis ; each antenna with 2 peg organs ; a peg organ *ca.* 6-8 µ caudad of posterior margin of antenna, another *ca.* 28 µ ventrad. Labrum small, slightly bulging. Mandibles (fig. 15) small, anterior sclerotized margin *ca.* 65-70 µ ; stout at bases, corium transparent ; tips testaceous, pointed ; a slight basal molar lobe (in one instance bearing two sharp, lanceolate teeth), a large protruding, triangular, blade-like tooth at the base of the cutting edge just distal to the molar eminence ; biting edge immediately anterior to basal tooth slightly convex, the convexity bearing 4-8 (or more) sharp, flattened, slightly diverging teeth. Details of labium and associated structures not worked out. Pronotum as large as meso- and metanotum combined. Spiracles (figs 11, 14) six per side, open, located at the level of the dorsal third of pronotal posterior margin and on abdominal segments 1-5 ; nearly circular in face view, *ca.* 16 µ in diameter, without a distinct vestibule. Distal half of body segment-12 slightly constricted transversely, weakly but distinctly bilobed in dorsal and ventral halves.

COMPARISON OF MEGASPILID LARVAE

Descriptions or comments on the morphology of last instar megaspilid larvae are scant : *Conostigmus timberlakei* KAMAL, 1926, and *C. zaglouli* KAMAL, 1926 (in KAMAL, 1939), *Dendrocerus carpenteri* (CURTIS, 1829) (as *Lygocerus testaceimanus* KIEFFER, 1907, and *L. cameroni* KIEFFER, 1907, in HAVILAND, 1920 ; *as Lygocerus niger* HOWARD, 1890, in SPENCER, 1926), *D. halidayi* (CURTIS, 1829) (? as *Lygocerus* sp., in WITHYCOME 1924 ; in VIAGGIANI, 1967), and *Dendrocerus sp.* (as *Lygocerus* species form Japan, in CLAUSEN, 1940). Insofar as described*, *Dendrocerus* last instar larvae are alike and differ from the three *Conostigmus* larvae by possessing a small head, a tapering body, a papillate abdominal integument, seven pairs of spiracles (on pronotum, metanotum, and abdominal segments 1-5), and a terminal, dorsal abdominal process. The *Conostigmus* last instar larvae are alike in having a large head, a less noticeably tapering body, a smooth integument, either six *or* eight spiracles, and are without a terminal abdominal process, although *C. quadratogenalis* sp. n. does have a slight terminal dorsal swelling. *C. quadratogenalis* sp. n. is like *C. timberlakei* KAMAL in having six pairs of spiracles (on pronotum and abdominal segments 1-5), but its spiracles are markedly dorsal, whereas in the latter the spiracles are equally notably ventral. *C. zaglouli* KAMAL has eight spiracles (distribution not noted by KAMAL), and in addition is distinctive by token of marked sclerotization of the margins of most of the abdominal segments. From *all* other last instar larvae, which are alike in having simple mandibles, *C. quadratogenalis* sp. n. most strikingly set apart by the 5-8 or more prominent, sharp teeth that beset the biting blade of each mandible. Unlike the other last instar larvae which are transparent to creamy white, the larva of *Dendrocerus halidayi* (CURTIS) is of a distinctive orange to orange-pink body color.

* The terminal conical process of the abdomen and the striking body color are the only described larval feature of *Dendrocerus halidayi* (CURTIS, 1829).

At 20°C the developmental times from eclosion of the free pupa to eclosion of the adult ranged from 9-12 days for the females, from 9.5-10.5 days for the males, the weighted mean being 10.4 days, a not unusual length to judge from the little that has been recorded for other *Conostigmus* and *Dendrocerus* species ; thus : *C. timberlakei* KAMAL, 6-8 days, temp. = ?, (KAMAL, 1939) ; *D. carpenteri* (CURTIS), 6-16 days, temp. = ? (as *Lygocerus niger* HOWARD, in SPENCER, 1926), 14-16 days, temp. = ? (as *Lygocerus testaceimanus* KIEFFER, in HAVILAND, 1920a, 1920b) or *mean* of 8 days, temp. = 25°C (as *Lygocerus aphidivorus* KIEFFER, in ROTHSCHILD, 1963)*. In the case of *C. quadratogenalis* sp. n. following eclosion to the pupa, the mean total times in hours for male and female to attain successive clearly recognizable states in coloration are much the same, although the male is initially somewhat the slower : to yellow eye color, male 57, female 48 ; sepia eye color, male 147, female 137 ; first sooty tinging of dorsum of head, mesosoma and metasoma,

* It should be noted that VOUKASSOVITCH (1925) gives for *Dendrocerus carpenteri* (CURTIS) (as *Lygocerus testaceimanus* KIEFFER) a total developmental time (egg to adult, in summer) of only 14-16 days.

male 170, female 177 ; full coloration, male 218, female 230 ; eclosion to adult, male 246, female 254 ; to end of imaginal period of rest (end of teneral state) and first passage of liquid meconium, male 270, female 304.

ETHOLOGY

Larval *Conostigmus quadratogenalis* sp. n. were first found on August 15, 1973, and then again on August 22, within a total of twelve hard earthen cells, made by last instar larvae of the mecopter *Boreus notoperates* COOPER, amid rhizoids in the thin sods of mosses growing on diorite boulders. In periods of drought and inactivity these cells individually protect the naked larva and the pupa to which it transforms. Eight cells contained only one parasitoid larva, three contained two, one cell harboured three larvae : in all of them, the nearly torpid parasitoids lay to one side or upon the collapsed, dried integument of a single last instar larval *Boreus* at the bottom of the cell. In one case, however, the larva of *Conostigmus* was still finishing its feeding. That larva, as it fed, had its posterior segments enclosed within the collapsed, soggy integument of its host, the remainder of its body being external and buckled upon itself, with its head immersed in the ooze about the distended wound. In a second instance, a seemingly normal last instar larva of *Boreus* had been placed aside in its opened cell, isolated for observation (along with others that were opened, whose occupants were entering pupation). At the time nothing was noticed that set this larva apart from the others. Yet on August 19 it was collapsed, a nearly fully fed larva of *Conostigmus* bent upon it, completing feeding. It seems unlikely that an earlier ectophagic stage of the parasitoid larva had been overlooked when the cell was opened on August 15.

Because of the facts recited, together with those concerning the life history of the naked larva of *Boreus notoperates* COOPER, especially its aestivation for long periods within a closed earthen cell not likely to be penetrated in periods of drought by an adventitious parasitoid, and finally by the failure to find, in the sample of 17 larvae, any ectophagic stages earlier than the last instar, it was concluded that *C. quadratogenalis* sp. n. is a primary parasitoid of *B. notoperates* COOPER, endophagic in its

early instars like the few other known hymenopterous parasitoids of species of *Boreus* (cfr COOPER, 1974). The open spiracles of the last larva of *C. quadratogenalis* sp. n., characteristic of ectophagic parasitoids, do not necessarily conflict with this supposition, for it is normal that the closed tracheal systems of endophages become open at the moult that immediately precedes the assumption of external larval life. Mandibles with toothed blades, hitherto unrecorded for ceraphronoid larvae, as a general rule are said by BEIRNE (1941) to be characteristic of ectophages. But even so, as BEIRNE points out, there are exceptions, and the remarkable, toothed mandibles of the last instar larva of *C. quadratogenalis* sp. n. are alike compatible with endophagy*. Because in a few instances more than one parasitoid larva developed from a single *Boreus* larva, *C. quadratogenalis* sp. n. is not obligatorily cannibalistic.

From the scattered occurrences of parasitized cells of *B. notoperates* COOPER larvae, it is unlikely that all were victims of a single ovipositing female of *Conostigmus*. Rather it is probable that termination of feeding by the parasitoid larvae at nearly the same time, and definitely at the same stage of their host, marks an orderly relation between the development of the parasitoid and its host : the parasitoid terminates its larval development coincidentally with that of its host. Like the host larva, it enters the pupal stage without spinning a cocoon, the host cell serving as its protective pupal enclosure.

The timetable of maturation following completion of feeding is a curious one, suggesting the occurrence of a facultative dia-

* *Conostigmus quadratogenalis* sp. n. therefore appears to be the first know endoparasitoid among the *Megaspilidae*. However, R. ASKEW (1971), without a cited reference, lists *Conostigmus* as including endoparasitism of dipteran larvae in its repertoire. *Conostigmus rufescens* KIEFFER, 1907 (det. DESSART, type seen) was recorded by A. LABORIUS (1972) from cocoons of the Cecidomyiid *Dasyneura brassicae* (WINNERTZ, 1853), but he did not state whether the parasitoid larva was endo- or ectophagic ; similarly, J. GUPPY (1961) recorded « *Conostigmus s.p* » from cocoons, of *Dasyneura*, and V. DELUCCHI & H. PSCHORN-WALCHER (1954) recorded *Dendrocerus serricornis* (BOHEMAN, 1832) as *Lygocerus piceae* (RATZEBURG, 1852) from « grown » fly larvae, but again without comment as to mode of attack ; etc. The *Conostigmus* species parasitoid on cocooned insects, for which mode of attack has been recorded, are ectophages (cf. DESSART, 1972).

pause. Two of the female larvae transformed to free pupae and emerged in the fall (October 30, November 15), at a time when imagoes of *B. notoperates* COOPER normally emerge. Emergence for both *Boreus* and (very likely) *Conostigmus* depends on the softening of the pupal cell wall by rain or melted snow. At this time, in their normal habitat, daytime temperatures are frequently mild and there is a second generation of overwintering *Boreus* larvae available and accessible as hosts (see COOPER, 1974). The other fully larvae of *Conostigmus* entered diapause, and efforts to break that diapause by cold treatment and an artificially prolonged light regimen of 14 ours duration per day did not affect all of them uniformly, their eclosion as free pupae and emergence as adults being widely scattered : December 19, 25 (2 females), January 15 (1 male), March 16, 17 (1 female, 1 male), May 20 (1 female), and June 18 (1 male). Three « larvae » remained obdurate, commenced to shrink, and were preserved in early June ; they proved to be pharate pupae (cfr HINTON, 1973).

It is therefor likely that normally some *Conostigmus* emerge as adults, mate and lay their eggs at a time that adult *Boreus* are active ; owing to facultative diapause others overwinter, giving a spring cohort, in a manner similar to *Dendrocerus carpenteri* CURTIS), (as *Lygocerus testaceimanus* KIEFFER ; WILSON 1938). As host larvae are available both in the fall and spring, *B. notoperates* COOPER having a two-year cycle, *C. quadratogenalis* sp. n. may thus have two to three generations per year, yet be limited to *B. notoperates* COOPER as its sole host and timed to its host's life cycle in the manner earlier described (COOPER, 1974). The long period of dormancy following completion of feeding, which may be of the order of two four months, is paralleled by the « resting period » of the syrphid parasitoid *Conostigmus zaglouli* KAMAL (cfr KAMAL, 1939). What aspect of its biology is met by that « rest » is not discussed by KAMAL, but in the case of *C. quadratogenalis* sp. n. the dormant period appears to function as an adaptation to the enforced periods of aestivation during prolonged spells of drought that regularly must be met by its only known host, *Boreus notoperates* COOPER.

That the adult wasp can live more than ten days without food or moisture is also a significant fact because escape from the cell of *Boreus* very likely depends not on the wasp's initiative, but — as stated above — on the chance of moisture, from rain storm or snow.

KIEFFER (1914) records specimens of *Dendrocerus carpenteri* (CURTIS) (as *Lygocerus aphidivorus inconspicuus* KIEFFER) that were taken overwintering in moss. While the known primary hosts of *C. carpenteri* (CURTIS) range widely, all are Hymenoptera, and it is not likely that KIEFFER's records reflect parasitism of the bryophagous *Boreus*. Nevertheless, they do suggest a path by which a megaspilid, perhaps a parasitoid of *Neuroptera,* might ultimately become associated with *Boreus* larvae. WITHYCOMBE (1924), PRUTHI & MANI (1942), MUESEBECK (1959), DESSART 1967, 1973, and VIGGIANI (1967) have all recorded nevropterous primary hosts for certain species of *Dendrocerus.*

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