

A DISCUSSION OF CYCLOPS VIRIDIS JURINE.

ROBERT CHAMBERS, JR.

BIOLOGICAL LABORATORY, COLUMBIA UNIVERSITY.

Cyclops viridis Jurine, or, as it was formerly called, *Cyclops brevicornis* Claus, the object of the classic researches of Haecker, is described as being represented in North America in the form of several varieties.

C. Dwight Marsh ('10), in his revision of the North American species of *Cyclops*, divides the species *viridis* into four varieties: var. *ingens* Herrick, var. *brevispinosus* Herrick, var. *parcus* Herrick, and var. *Americanus* Marsh.

Ingens includes the largest forms of the species and possibly corresponds to the European var. *gigas* Claus.

Americanus is the most abundant variety of *viridis* in American waters. It is to be met with in almost any ditch or small pond. *Parcus* is much more local in its haunts but in the localities where it is to be found it may be abundantly represented. I have never found the two varieties together. *Parcus* is, on the average, smaller than *Americanus*.

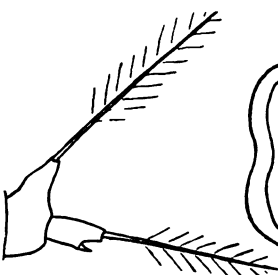
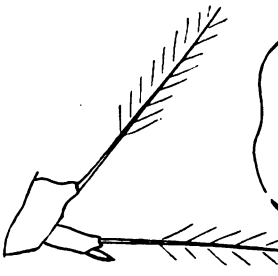
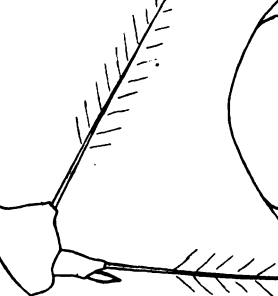

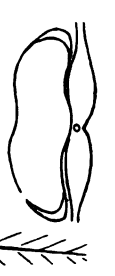

In the accompanying table I have indicated the main features distinguishing the European and the two last mentioned American varieties.

The inner margin of the furcal rami of the tail is never ciliated in the two American varieties as it is in the European form.

The rudimentary fifth thoracic appendage of the European *viridis* (see table) is described by Schmeil ('92) as having the small spine on the inner margin of the second segment either a mere cuticular protuberance or connected with that segment by a distinct joint. The latter feature is characteristic of the two American varieties (see table).

The number of spines on the terminal segments of the outer rami of the four swimming appendages in the European *viridis* and in *parcus* are two for the first pair of appendages and three

Cyclops viridis Jurine (excl. var. *gigas*, *ingens*, and *brevispinosus*).

	European Variety. •	Var. <i>parvus</i> Herrick.	Var. <i>americanus</i> Marsh.
1. Fifth foot (that of the Eur. var. is drawn on a scale half of that of the other two).			
2. Receptaculum seminis (that of Eur. var. from Claus).			
3. Inner margin of furcal rami.	Ciliated.	Devoid of cilia.	Devoid of cilia.
4. Spine formula.	2, 3, 3, 3.	2, 3, 3, 3.	3, 4, 4, 4.
5. Average body-length.	2.2 mm. (Wolf)	1.4 mm.	1.5 mm.
6. Chromosome number.	12	6	10

for the next three pairs. *Americanus* has three on the first and four on the other three pairs.

E. F. Byrnes ('09) considers *parvus* and *Americanus* to be heterogenous¹ forms of the same species. This she assumes from the fact that the only fundamental difference noted between them is the armature of the swimming appendages and this appears to be variable, for occasionally one may find an adult *Cyclops* unmistakably *C. Americanus*, in which most of the swimming feet agree with *C. Americanus* in having four spines on the terminal segments of the outer rami, while others are in the condition characteristic of *C. parvus*, having but three spines on the terminal segments of the rami.

Neither Byrnes nor Marsh ('10) have remarked upon the dissimilarity in the shape of the receptaculum seminis of the two forms. Systematists working on Cyclopidae admit that the most constant and characteristic feature for a given species is the shape of that organ. It is remarkable, therefore, that more care is not taken in figuring the seminal receptacle of described forms.

In all three varieties the receptaculum consists of a larger antero-median portion and two narrower postero-ventral portions which are carried out laterally as the sperm ducts.

Parvus possesses a receptaculum (see table) which resembles that of the European *viridis* in that the upper portion is concave anteriorly. That of *Americanus* (see table) is convex.

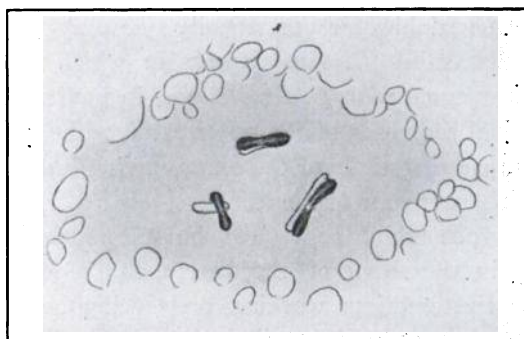
Another point which seems to leave no room for doubt as to the distinctness of the two varieties is the constant difference in their chromosome number. I have found that the somatic chromosome number in *C. Americanus* is 10 whereas in *C. parvus* it is 6.

Specimens collected in widely separated localities, as Toronto, Woods Hole, and New York, have thus far shown this difference in chromosome number to be constant for the two varieties.

A specimen taken from a pure culture of *C. parvus* showed a variation in the spines of its thoracic limbs, the spine formula being 3, 4, 4, 3 or 4 (?). A systematist would probably consider

¹ The term *heterogeny* is used here to denote the existence of two adult forms which represent successive generations, both of which are sexually mature, but morphologically unlike.

this a case of interrelationship between *C. parvus* and *C. Americanus*. That this cannot be so is to be seen from the following: I was fortunate enough to section the specimen when the chromosomes of its oviduct eggs were in the so-called "biserial arrangement" and where the count is particularly easy. The presence



Nucleus of oviduct egg of *Cyclops parvus*, showing the three pairs of chromosomes in "biserial arrangement."

of three pairs of chromosomes (see text figure) leaves no doubt as to the identity of the specimen.

The European *Cycl. viridis* has 12 chromosomes (Haecker, Braun).

Haecker ('97) described *Cyclops brevicornis* Claus (*viridis* Jurine) which he studied as being anywhere from 3.5–5 mm. in length. The size mentioned indicates that he was probably working with var. *gigas* Claus. It is remarkable that he gives the somatic chromosome number to be 24, although in the ovary he describes the chromosomes as bivalent, being 12 in number.

Braun ('09) also studied *Cyclops viridis* Jurine but not the variety *gigas*. He gives the somatic number of chromosomes for the typical species as 12. Unfortunately he does not mention sizes except in stating that the species varies between 1.5–5.1 mm. in length.

Schmeil ('92) gives the body length of the typical European *viridis* to be anywhere from 1.5–3.5 mm.

Wolf ('05) places the average length at 2.2 mm. Our American *parvus* on the other hand is not more than half the average size

of the European form. The specimens I have met with have never been over 1.5 mm. in length and are much more frequently between 1.2 mm. and 1.4 mm. long.

The drawings in the accompanying plate also show the disparity in size between the American and the European forms, that of the fifth foot of the European variety, from a specimen in my possession, being drawn to a scale half of that of the other drawings.

Is it not possible that we have here a case similar to that which R. R. Gates ('09) discovered in *Oenothera*? *Oenothera gigas*, a giant mutant of *O. Lamarckiana*, was found to possess 28 chromosomes or double the number of the parent form (14). Its cells were found to be correspondingly larger. Gates suggested that in an egg of *O. Lamarckiana* a double number of chromosomes arose from a division of the chromosomes unaccompanied by nuclear and cell division soon after fertilization and that this egg developed into the *O. gigas* form.

Either *C. parvus* or the European *C. viridis* may conceivably be a mutation one of the other if, in the one case, all of the chromosomes split into halves without subsequent nuclear division, or, in the other, go into mitosis without splitting so as to produce the number 12 for the European *viridis* or 6 for the American *parvus*. The cells of the European *viridis* containing twelve chromosomes would then be twice the size of those of *C. parvus* which has only six. The actual discrepancy in size between the two forms could thus be explained.

Note.—Since the above was sent to the printers I have secured specimens of a *Cyclops viridis* from several pools near Edgewater, N. J. They are mostly from 2–3 mm. in length although several mature individuals measure only 1.4 mm.

Not only do they resemble the typical European *viridis* Jurine in size; in the ciliated inner margin of the furcal rami; in the fifth foot with the very small barely jointed spine on the second segment; but also in the spine formula for the four swimming feet which is 2, 3, 3, 3; and, most significant of all, in the shape of the seminal receptacle, the figure shown in the table for the European *viridis* being an exact picture of the same organ in the form under discussion.

And, lastly, the somatic chromosome number I have found to be 12, the same as that of the European *viridis*.

I see no reason why this form should not be entitled to the exclusive rights of the name *Cyclops viridis* Jurine; and *C. Americanus*, *C. parvus*, and *C. brevispinosus*, each with its distinctive chromosome number, spinal armature for the swimming feet, and seminal receptacle, be raised to the rank of separate species.

That the individuals I have just secured are not to be classed with *C. ingens* Herrick I conclude from Herrick's statement ('95) that the latter is merely an exaggerated form of *C. Americanus*. Neither are they to be compared with the forms which Miss Byrnes describes as *C. ingens* (?) for this latter species Miss Byrnes distinctly states as possessing the *brevispinosus* spinal armature of the swimming feet. My individuals, on the other hand, possess the *parvus* spinal armature for both the outer and inner rami of the swimming feet, and this armature is identical with that of the European *viridis*.

LITERATURE CITED

Braun, Alex.

- '09 Die spezifische Chromosomenzahlen der einheimischen Arten der Gattung *Cyclops*. Arch. f. Zellf., 3.

Byrnes, E. F.

- '09 The Freshwater *Cyclops* of Long Island. Cold Spring Harbor Monographs, VII. Pub. by Brooklyn Inst. of Arts and Sc.

Claus, C.

- '93 Neue Beobachtungen über die Organisation und Entwicklung von *Cyclops*. Arb. Zool. Inst. d. Univ. Wien, Bd. 10.

Gates, R. R.

- '09 The Stature and Chromosomes of *Ænothra gigas* DeVries. Arch. f. Zellf., 3.

Haecker, V.

- '97 Die Keimbahn von *Cyclops*. Arch. f. mikr. Anat., 49.
'03 Über das Schicksal der elterlichen u. grosselterlichen Kernanteile. Jen. Zeitschr., 37.

Herrick, C. L., and Turner, C. H.

- '95 Synopsis of the Entomostraca of Minnesota. Geol. Nat. Hist. Surv. of Minn.

Marsh, C. Dwight.

- '10 A Revision of the North American Species of *Cyclops*. Trans. Wis. Acad. Sc. and Letters.

Schmeil, O.

- '92 Deutschlands freilebende Süsswasser-Copepoden. I. Theil, Cyclopidae. Bibl. Zool. (Leuckart u. Chun), Heft 11.

Wolf, Eugen.

- '05 Die Fortpflanzungsverhältnisse unserer einheimischen Copepoden. Zool. Jahrb. Syst., 22.