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ON THE OCCURRENCE OF *HYDROMERMIS CONTORTA* (KOHN) (NEMATODEA) PARASITIZING MIDGES (CHIRONOMIDAE) IN THE CAMARGUE

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Introduction.

The nematode, *Hydromermis contorta* (Kohn) of the family Mermithidae, has been found parasitizing members of the Chironomidae in Europe and America (see TABLE 1).

During the spring of 1971, larval chironomid populations were sampled at various localities in the Camargue to search for natural parasites. This was one aspect of a general ecological study on chironomid populations in the Camargue currently being conducted by the junior author. One population was found parasitized by *Hydromermis contorta* (Kohn). The parasites were found in *Chironomus annularius* (Mg.) and *C. dorsalis* (Mg.), thus establishing 2 new host records for this mermithid (*Fig.* 1 A).

TABLE I. — List of hosts for *Hydromermis contorta* (Kohn).

Host species	Locality	Reference
Chironomus annularius (Mg.)	France	Poinar and Tourenq (present study)
Chironomus dorsalis (Mg.)	France	Poinar and Tourenq (present study)
Chironomus plumosus L.	Germany	Köhn, 1905
Chironomus plumosus L.	America	Johnson, 1955
Chironomus plumosus L.	France	Poinar and Tourenq (present study)
Chironomus tentans Fabr.	Italy	Parenti, 1962
Chironomus thummi K.	France	Comas, 1927
Tanytarsus gregarius (K.)	Germany	Wülker, 1961

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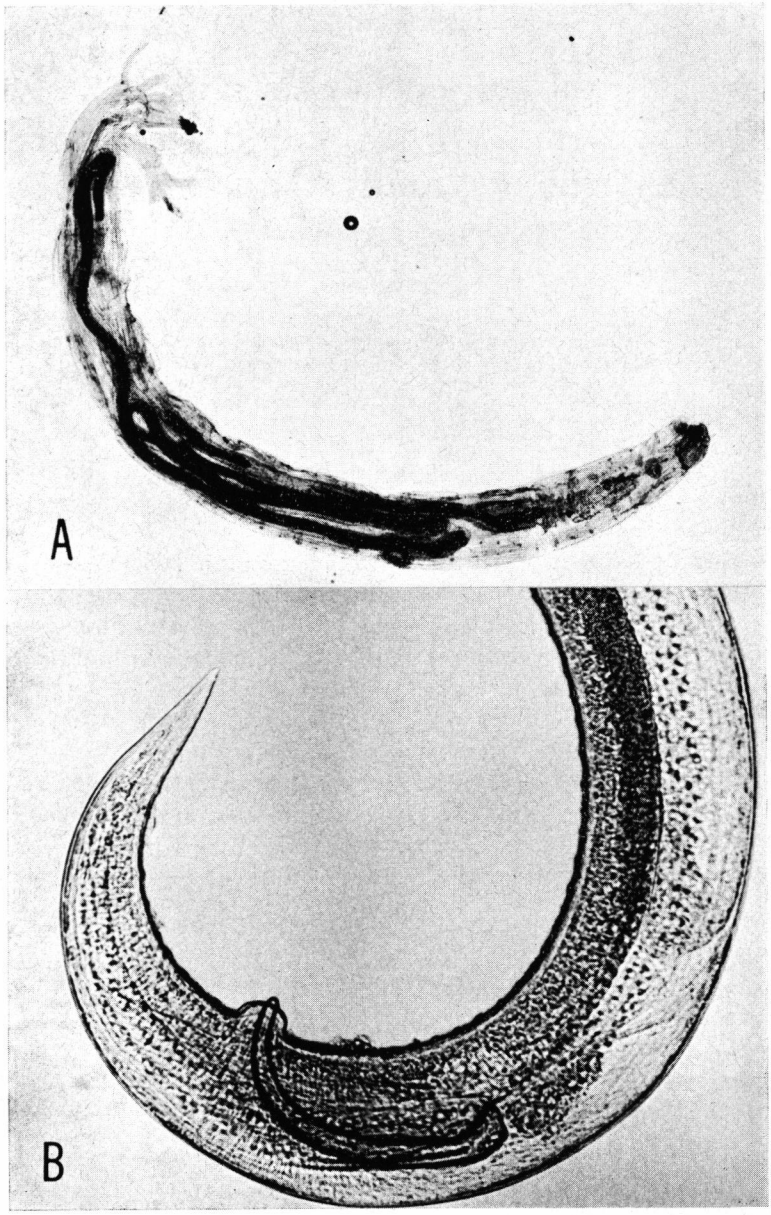

FIG. 1. — A : *Hydromermis contorta* (Kohn) within the last instar larva of *Chironomus annularius* (× 11,4). — B : Detail of the tail end of a male of *Hydromermis contorta* (Kohn) showing the C — curved spiculum (× 125)

The present paper presents data on the occurrence and seasonal distribution of *H. contorta* and discusses aspects of its morphology and variation in comparison with previous reports.

Materials and Methods.

Chironomids from nematode-infested areas were collected from irrigation and evacuation canals at the Tour du Valat, in the Camargue from April to July, 1971. The water was always fresh, permanent and lightly flowing. The chlorosity varied from 0 to 0.2 grams of chloride ions/liter. The water temperature remained fairly constant, varying from 17 °C in April to 24 °C in July. The pH varied from 7 to 7.6 during the same period. The water was relatively poor in dissolved oxygen, containing from 7 ppm (parts per million) in April to 4 ppm in June (WINKLER method) (saturation 40 → 70 %). The total carbon dioxide content (measured with the VAN SLYKE method) showed a value between 100 and 200 mgr/liter.

Chironomid larvae were sampled by draggind a net over the bottom of the canals, which were approximately 1 meter deep. The collected larvae were separated into the taxonomic groups, Chirinominae and the Tanypodinae :

Chironominae	*Chironomus anthracinus*	Zett.
	Chironomus annularius	(Mg.)
	Chironomus plumosus	L.
	Chironomus dorsalis	(Mg.)
	Chironomus thummi thummi	Str.
	Chironomus riparius	(Meig.)
	Limnochironomus notatus	(Mg.)
	Microtendipes pedellus	(de Geer)
	Polypedilum pharao	K.
	Polypedilum nubeculosum	(Mg.)

Those making up the latter group were :

Tanypodinae	*Procladius culiciformis*	(Mg.)
	Tanypus punctipennis	(Meig.)
	Psectrotanypus varius	(Fabr.)

The above species were recovered from the collecting site at each sampling period. In the laboratory, the larvae were washed and placed in large pans for observation. The parasitized forms were removed and held in smaller dishes until the nematodes emerged. For morphological studies, the nematodes were killed with gentle heat, fixed in 3 % formalin and processed to glycerin.

Results.

The results of sampling populations of Chironomidae for the presence of *H. contorta* from April to July of 1971 are given in Table II. Throughout the experimental period, *H. contorta* was found only parasitizing the larvae of *C. annularius* Mg., *C. dorsalis* Mg. and *C. plumosus L.*

TABLE II. — Results of sampling populations of Chironomidae for the presence of *Hydromermis contorta* (Kohn) during the spring of 1971 in the Camargue.

Date	*Chironominae*			*Tanypodinae*		
	No. examined	No. parasitized	(%)	No. examined	No. parasitized	(%)
April 2	100	46	(46)	16	0	(—)
April 23	174	56	(32)	11	0	(—)
May 17	451	21	(5)	—	—	
June 1	380	0	(—)	—	—	
July 8	205	1	(0.5)	123	0	(—)
July 9	206	0	(—)	120	0	(—)
July 10	518	0	(—)	162	0	(—)
July 30	223	0	(—)	103	0	(—)

The percentage of parasitism was heaviest in the beginning of April and then dropped off rapidly toward the middle of May. Although the hosts were present in June and July, the parasitized chironomids were very rare.

When kept at 20 °C, the mermithids emerged the day after collecting the parasitized larvae and began mating at once. In contrast to the terrestrial mermithids, the eggs for *H. contorta* were fully formed upon emergence from the host and oviposition commenced from 1-3 days after emergence. An unusual feature of *H. contorta* is that the adult nematodes emerge from the host, having completed their last molt in the chironomid. In contrast, all other mermithids have one or 2 molts after leaving their host. Perhaps this feature can serve as a diagnostic character. The preparasitic juveniles emerged from the eggs 7-10 days after oviposition and some remained alive under refrigeration (5 °C) for 66 days. Attempts at infecting larvae of *Aedes aegypti* with the infective stages of *H. contorta* were unsuccessful.

A description of the specimens of *H. contorta* taken from *Chironomus annularius* follows : The first figure following the character is the average value of observations made and those in parenthesis represent the range. All measurements are in millimeters.

Hydromermis contorta (Kohn).

Adult : Containing the diagnostic characters of the genue *Hydromermis,* namely, 6 head papillae, 8 hypodermal chords at midbody, cuticle lacking cross fibers, an S-shaped vagina and a short single spicule in the male.

Female : (n = 10) Length 38.1 (31.1-54.8); width .20 (.20-.34); diameter of head .07 (.06-.09); head to nerve ring .26 (.23-.29); length amphid .012 (.009-.013); head to tip of amphid .021 (.015-.026); diameter of amphidial opening .006 (.004-.009); length of vagina .46 (.36-.58); % vulva (39-49); egg diameter (in uterus) .052 (.046-065). Tail pointed.

Male : (n — 10) Length 23.1 (14.4-30.5); width .17 (.14-.20); diameter of head .07 (.06-.09); head to nerve ring .23 (.19-.27); length amphid .014 (.013-.016); head to tip of amphid .022 (.013-0.30); diameter of amphidial opening .008 (.006-.010; length of spicule .29 (.20-.39); length of anus .35 (.31-.47). Spicule with a characteristic bend and containing minute protuberances on the tip (*Fig.* 1 B). Tail with 3 broken rows of genital papillae, ranging from 30-50 in each pre anal row and 10-20 in the post anal rows. These papillae often extend to just behind the tip the tail terminus. Tail sharply pointed.

Infective stage juveniles :(n = 10) Length .58 (.54-.61); width .013 (.012-.015).

Hosts : *Chironomus annularius* Mg., *C. dorsalis* Mg., *C. plumosus* L.

Locality : Irrigation and evacuation canals, Tour du Valat, Camargue.

Variation : A comparison of the quantitative values of *Hydromermis contorta* (Kohn) from 4 seperate studies is shown in Table III. It is interesting to see that although the values vary slightly, the figures given for the range of most characters overlap, thus indicating that *H. contorta* appears to be a fairly stable species. Even in America, where JOHNSON (1955) found the nematodes generally larger, there is still an overlap in size with European material.

JOHNSON (1955) also felt that the European form had a blunter head than the American *contortus,* basing his conclusions on the drawings of HAGMEIER (1912). However from the present material, it appears that the curvature of the head is a variable character and no definite conclusions based on geographical separation can be drawn. Other characters noted here were the presence of numerous anal papillae and small denticles on the tip of the spicule, in contrast to the 4 teeth shown for *H. contorta* by HAGMEIER (1912).

TABLE III. — Measurements of *Hydromermis contorta* (Kohn) from various localities (all in mm).

Character	KOHN (1905)	HAGMEIER (1912)	JOHNSON (1955)	Present study
length — female	26-50	19-40	50 (23-70)	38 (31-54)
— male	13-26	14-25	26 (15-40)	23 (14-30)
width — female	.18-.37	.18-.24	.31 (.22-.44)	.27 (.20-.34)
— male	.07-.21	.13-.19	.24 (.12-.33)	.17 (.14-.20)
head diameter				
— female	—	.053-.075	.066 (.051-.087)	.072 (.068-.090)
— male	—	.062-.075	.054 (.041-.071)	.071 (.061-.085)
head to nerve ring				
— female	—	.198-.260	.270 (.212-.358)	.259 (.231-.285)
— male	—	.206-.224	.222 (.161-.294)	.230 (.193-.270)
length vagina	.50	—	.50	.46 (.39-.59)
% Vulva	—	—	45 (32-50)	45 (39-49)
egg diameter	.053-.068	.060	.060	.053 (.047-.065)
length spicule	.20	.20-.30	.314 (.235-.472)	.29 (.20-.39)
length male tail	—	.185-.264	.348 (.170-.447)	.354 (.308-.470)
length infective stage	.25-.49	.51-.58	.57	.58 (.54-.61)
width infective stage	.003-.012	.013	.012	.013 (.012-.015)

These findings agree with JOHNSON's description of the American *H. contortus*.

It should also be noted that there has been some confusion regarding the taxon *Hydromermis contorta* in the literature since there are 2 species of nematodes known by this name. VON LINSTOW (1889) described *H. contorta* from samples of mermithids he found in mud. Although his samples were not adequate, he could determine that cross-fibers were present and there were 6 hypodermal chords, characters which are found in the genus *Paramermis*. KOHN (1905) described his *H. contorta* he collected from *C. plumosus* as lacking cross fibers and having 8 hypodermal chords, characters belonging to the genus *Hydrodermis*. Although both VON LINSTOW and KOHN might have felt they were dealing with the same worm, it is now obvious that they were working with different species. In this paper, all discussion pertains to KOHN's *Hydromermis contorta* which has been re-discovered since by various authors.

Discussion.

Finding *H. contorta* (Kohn) only in 3 host species in the areas sampled, although there were many other chironomid larvae in

the same habitat, suggests that host specificity exists in the ability of *H. contorta* to parasitize members of this group.

Many samples of chironomids (*Chironomus* sp., *Cricotopus* sp.) were taken from aquatic habitats in the Camargue varying in salt concentration from zero to very salty, however mermithids were only found parasitizing midges in fresh water. As for *H. contorta*, its limited distribution might depend on the concentrated supply of a suitable host as well as the lack of salinity of the water. Mermithids occurring in brackish or salt water are uncommon and thus far, *Agamomermis* culicis, a parasite of the mosquito, *Aedes sollicitans*, is the only nematode known to us that is capable of surviving in salty water. It would be interesting to determine if salt tolerance by mermithid nematodes is really as rare as it seems and if they can be encouraged to adjust to living in water with low salt concentrations.

The high percentage of parasitism observed on April 2 indicates that *H. contorta* is an important factor limiting chironomid populations at certain periods in the year.

The presence of the nematodes is undoubtedly connected with the host's life cycle, and there is probably a synchronization between the emergence of the infective stage nematode and the presence of young second or third instar chironomid larvae. Although our results indicate a single generation each year, more samples should be taken since JOHNSON (1955) found a peak of *C. plumosus* larvae attacked by *H. contorta* in November and again in March and April in Indiana and concluded that there are 2 parasitic generations per year. How this is accomplished when it is agreed that *C. plumosus* has only a single generation per year is not known.

SUMMARY

Hydromermis contorta (Kohn) (Mermithidae : Nematodea) was found parasitizing *Chironomus annularius* Mg, *C. dorsalis* Mg and *C. plumosus* L. in the Camargue. The first 2 species are new host records for this mermithid nematode. The percentage of parasitism was followed from April to July, 1971 and reached 46 (n = 100) early in April. The morphology of the adult nematodes was studied and quantitative measurements were made and compared with those reported by earlier authors. These parasites may serve as an important controlling agent of chironomids in certain areas in the Camargue.

SUR LA PRÉSENCE DE *HYDROMERMIS CONTORTA* (KOHN) PARASITE DES LARVES DE CHIRONOMIDES DE CAMARGUE.

En Camargue les larves de *Chironomus annularius* Mg, *Chironomus dorsalis* Mg et *Chironomus plumosus* L. sont parasitées par *Hydromermis contorta* (Kohn) (Mermithidae : Nematodea). Les larves de *Chironomus*

annularius et *C. dorsalis* sont des hôtes nouveaux pour ce mermithide parasite. Le pourcentage des larves parasitées a été suivi d'avril à juillet 1971; dès avril le pourcentage atteignait 46 %. La morphologie du nématode adulte est étudiée, les mesures effectuées sont comparées avec celles trouvées par les auteurs ayant déjà décrit cette espèce. Ces parasites pourraient servir à contrôler l'effectif des Chironomides dans certaines zones de la Camargue.

ÜBER DAS VORKOMMEN DES PARASITEN *HYDROMERMIS CONTORTA* (KOHN) (NEMATODEA) IN DEN CHIRONOMIDEN-LARVEN IN DER CAMARGUE

In der Camargue ist der Parasite *Hydromermis contorta* (Kohn) (Mermithidae : Nematodea) auf den Larven folgender Chironomiden gefunden worden : *Ch. annularius* (Mg), *Ch. dorsalis* (Mg), *Ch. plumosus* (L.).

Die Larven der *Ch. annularius* und *Ch. dorsalis* sind neu als Parasitenträger dieses Mermithiden.

Der Prozentsatz der erkrankten Larven, die vom April bis Juli 1971 erfasst worden sind, betrug schon im April 46 %.

Die Morphologie des ausgewachsenen Nemathoden ist untersucht worden. Die ausgeführten Messungen wurden mit denjenigen verglichen, die schon von andern Autoren über die gleiche Art vorliegen.

Dieser Parasite könnte zur Kontrolle des Chironomidenbestandes in gewissen Gebieten der Camargue dienen.

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