Ann. Naturhist. Mus. Wien	97 B	57 - 74	Wien, November 1995

Zelinkaderes klepali sp.n., from shallow water sands of the Red Sea

(Kinorhyncha: Cyclorhagida: Zelinkaderidae)

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Abstract

A new species of *Zelinkaderes* HIGGINS, 1990, (Cyclorhagida, Zelinkaderidae) is described by means of light and scanning electron microscopic techniques from subtidal sand between coral patches and seagrass habitat of the Red Sea. *Zelinkaderes klepali* sp.n. can be classified within the genus *Zelinkaderes* due to the following characters: neck consisting of 16 indistinct placids fused with the first trunk zonite; the first and second trunk zonite are complete rings; the third to tenth trunk zonite are provided with midventral articulations; a midterminal spine is present; middorsal spines occur on the trunk zonites four, six, eight to eleven; cuspidate spines are present; the oral styles are bipartite. The number of 69 scalids and their special pattern, the terminal trunk zonite in the form of four cuticular plates, and the occurrence and distribution of the lateral spines easily distinguish *Z. klepali* sp.n. from the other *Zelinkaderes* species. A fine structural analysis of the cuticle reveals a new type of trunk cuticle, including a new type of midventral articulation, which is compared within kinorhynchs.

Key words: Kinorhyncha, Cyclorhagida, *Zelinkaderes*, new species, Red Sea.

Zusammenfassung

Eine neue Art von *Zelinkaderes* HIGGINS, 1990, (Cyclorhagida, Zelinkaderidae) aus seichten, subtidalen Sanden des Roten Meeres wird mit Hilfe von licht- und elektronenmikroskopischen Techniken beschrieben. *Zelinkaderes klepali* sp.n. kann aufgrund folgendender Merkmale der Gattung *Zelinkaderes* zugeordnet werden: Hals aus 16 Plakiden bestehend und mit erstem Rumpfzonit verschmolzen; erstes und zweites Rumpfzonit ringförmig; drittes bis zehntes Rumpfzonit mit midventraler Artikulation; midterminaler Stachel vorhanden; middorsale Stacheln am vierten, sechsten, achten bis elften Rumpfzonit ausgebildet; "cuspidate" Stacheln vorhanden; Oralstyli bestehend aus zwei Elementen. *Zelinkaderes klepali* sp.n. unterscheidet sich von anderen *Zelinkaderes* Arten durch das Vorhandensein von 69 Skaliden und deren spezielle Anordnung, durch das terminale Rumpfzonit im Form von vier kutikulären Platten sowie durch die Anzahl und Verteilung der lateralen Stacheln im Rumpf. *Zelinkaderes klepali* sp.n. weist einen neuen Typus von Rumpfkutikula und midventraler Artikulation auf, welche innerhalb der Kinorhynchen verglichen werden.

Introduction

Only a few kinorhynch species have been described from the Red Sea, all of them from Hurgada (Egypt). *Echinoderes brevispinosus* HIGGINS, 1966, and *Pycnophyes egyptensis* HIGGINS, 1966, are found in subtidal sandy muds, whereas *E. riedli* HIGGINS, 1966, occurs in detritus rich sands near the low tide level (HIGGINS 1966). This is the first description of a new species ascribed to the genus *Zelinkaderes* HIGGINS, 1990. It originates from a subtidal, sandy habitat of the Northern Bay of Safaga.

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The study of this third species of the recently described genus *Zelinkaderes* was made by means of light and electron microscopic techniques in order to compare the taxonomic characters, especially those of introvert and mouth cone. Additionally, it is one aim of this publication to study for the first time the fine structure of the cuticle in a non-armoured kinorhynch and to compare it with the armoured cuticular type.

Acknowledgements

I am grateful to Prof.Dr. F.F. Steininger, Dr. Piller, Dr. Pervesler (University of Vienna), and Dr. Abbas Mansour (University of Quena) for the possibility of participating in a field trip to Safaga, Red Sea, in September 1992. I especially thank Prof.Dr. W. Mayer and Prof.Dr. C.F. Bardele (University of Tübingen) for their hospitality at the Lehrstuhl für Spezielle Zoologie and for providing all material and equipment necessary for such a study. I thank also Mr. H. Schoppmann for his technical assistance with the scanning electron microscope, Dr. S. Neulinger for her excellent illustrations, and Mag. S. Kampfer and Dr. J.H. Nebelsick for their support and help during our stay in Egypt.

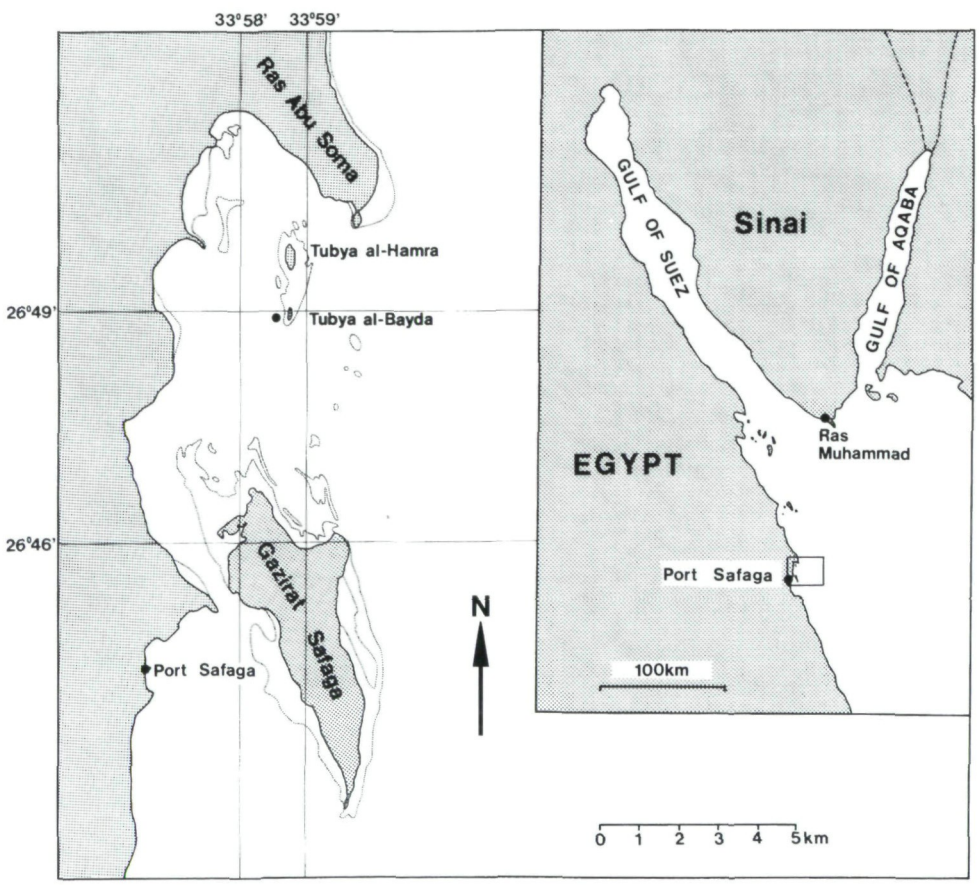


Fig. 1: *Zelinkaderes klepali* sp.n. Geographical map showing type locality (point) east of Tubaya al-Bayda.

Abbreviations used in figures

b	cuticular bristles on posterior border of first to fourth trunk zonite
bb	bifid cuticular bristles
d	middorsal spine (followed by trunk zonite number)
dp	dorsal cuticular plate of terminal trunk zonite
dv	appendage of dorsoventral musculature
e	epidermis
ec	epicuticle
f	pectinate fringe
go	gonopore
i	introvert
ic	intracuticle
la	lateral acicular spine (followed by trunk zonite number)
lc	lateral cuspidate spine (followed by trunk zonite number)
lp	lateral cuticular plate of terminal trunk zonite
ltas	lateral terminal accessory spine
lts	lateral terminal spine
mc	mouth cone
mo	mouth opening
mssp	modified sensory spot
mts	midterminal spine
mva	midventral articulation
ne	neck
p	pharyngeal style (followed by ring number)
pb	pharyngeal bulb
pc	pharynx crown
pcf	procuticle, fibrillar
pch	procuticle, homogeneous
s1	spinoscalid type 1
s2	spinoscalid type 2
ts	trichoscalid
vp	ventral cuticular plate of terminal trunk zonite
z	trunk zonite (followed by number)

Material and methods

Samples of carbonate sand were collected between small coral patches and seagrass beds from 0.5 to 1.5 m depth ca. 100 m east of the southern tip of Tubya al-Bayda in the Northern Bay of Safaga, Red Sea (26° 49' N, 33° 58' 30" E) in September 1992 (Fig. 1) (see also PILLER & PERVESLER 1989, PILLER & MANSOUR 1990). At that time the temperature of the sediment surface layer down to 5 cm depth ranged from 26.5 to 27.5°C. *Zelinkaderes klepali* sp.n. was found in the oxidized sediment layer above the redox potential discontinuity which was situated between 3 and 5 cm depth.

Specimens of *Zelinkaderes klepali* were extracted by decantation and fixed either in 4 % paraformaldehyde in 0.1 M phosphate buffer at pH 7.4 or in 3 % glutaraldehyde in the same buffer. Some of the specimens were transferred into freshwater for a few minutes before fixation due to evert the introvert and the foregut, thus exposing the scalids of the introvert and the oral styles and pharyngeal styles of the buccal epithelium. For light microscopic observations, the animals were transferred either in glycerin or in polyvinyl-lactophenol (Chroma). Examinations of the whole mounts, photographs, and measurements with a scaled eyepiece were made with a Zeiss Axioplan; illustrations were made with a camera lucida on a Zeiss Standard GFL.

For scanning electron microscopic observations, the adult specimens were postfixed in 2 % osmium tetroxide in 0.1 M cacodylate buffer at pH 7.4 for two hours, rinsed in the same buffer, postfixed in 3 % glutaraldehyde and 8 % tannic acid in 0.1 M cacodylate buffer at pH 7.4 for five hours, rinsed in the same buffer, postfixed again in 2 % osmium tetroxide in 0.1 M cacodylate buffer at pH 7.4 for two hours, dehydrated in ethanol,

critical point dried (Polaron E3000 Series II), coated with a layer of palladium-gold (Balzers SCD 030), and examined on a Cambridge Stereoscan 250 Mk2. Some of the 25 examined specimens were cleaned with an ultrasonicator for a few seconds before postfixation in order to remove mud particles, mucus, and bacteria.

For transmission electron micrsocopy, specimens were fixed in a mixture of 3 % glutaraldehyde, 2 % paraformaldehyde, 1 % acrolein, 2.5 % dimethylsulfoxide in 0.1 M cacodylate buffer at pH 7.4 for several weeks, rinsed in the same buffer, postfixed in 2 % osmium tetroxide in 0.1 M cacodylate buffer for two hours, rinsed in the same buffer, dehydrated with a series of ethanol, and embedded in Spurr's epoxy resin. Section of several animals were made with a LKB 4800 ultrotome. The dioxan-formvar coated copper slot-grids were stained with satured uranyl actetate in 50 % ethanol and 0.4 % aqueous lead citrate and viewed on a Zeiss EM9.

Zelinkaderes klepali sp.n.

(Figs. 2 - 43)

Material examined. Holotype: adult female (Evertebrata Varia Collection, Naturhistorisches Museum Wien no.3351, Figs 2, 3); Allotype: adult male (no.3352, Figs. 4 - 7, 10, 11, 15, 16); Paratypes: 4 adult females (no.3353 - 3366, Figs. 9, 12, 13, 17 - 19) and 4 adult males (no.3357 - 3360, Figs. 14, 20), additional 30 paratypes (in the author's collection), 25 adult specimens for SEM studies (Figs. 21 - 39), five adult specimens for TEM studies.

Type locality. Carbonate sand, 0.5 to 1.5 m depth, ca. 100 m east of the southern tip of Tubya al-Bayda in the Northern Bay of Safaga, Red Sea (26° 49' N, 33° 58' 30" E), collected in September 1992.

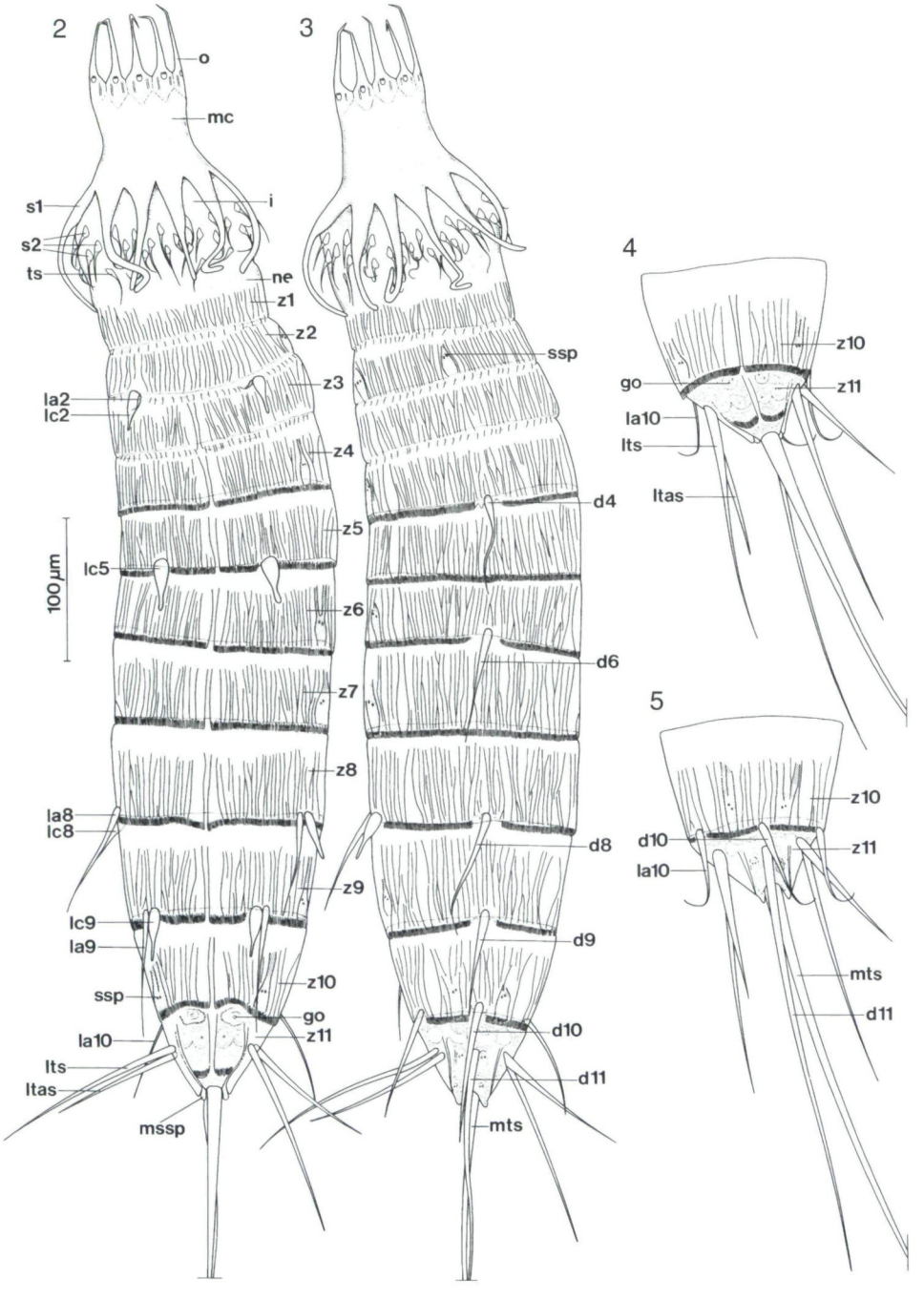
Etymology. This species in named in honor of Prof.Dr. W. Klepal, my doctoral mother and teacher in electron microscopy at the University of Vienna.

Diagnosis

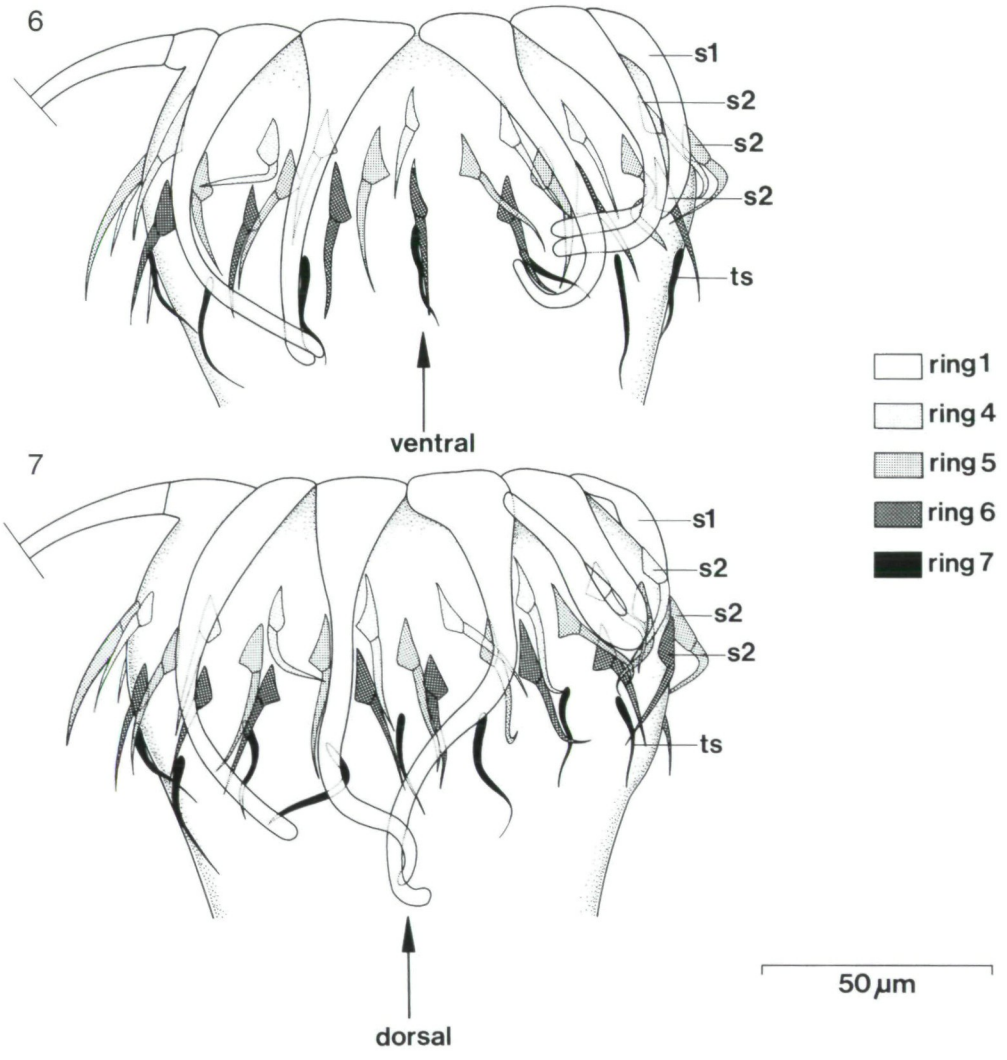
Introvert with five rings of scalids (from anterior to posterior 10, -, -, 15, 15, 15, 14); neck with 16 indistict placids; first and second trunk zonite are rings; third to tenth trunk zonite with midventral articulation; 11th trunk zonite with midventral, subventral, and subdorsal articulations; lateral acicular spines present on trunk zonites two, eighth, nine, and ten; lateral cuspidate spines present on trunk zonites two, five, eight, and nine; middorsal spines present on trunk zonites four, six, eight to eleven; lateral terminal spine longer than lateral terminal accessory spine; midterminal spine; sensory spots ventrally on the trunk zonites nine, ten, and eleven, dorsolaterally on the trunk zonites two, four, six, and seven, dorsally on the trunk zonite ten, and middorsally on the trunk zonite two.

Description (Table 1)

Introvert (i). The introvert bears 69 scalids, arranged in 5 rings, from anterior to posterior 10, -, -, 15, 15, 15, 14 scalids per ring (Figs. 6 - 8). The anteriormost first ring is com-



Figs. 2 - 5: *Zelinkaderes klepali* sp.n. Camera lucida drawings. (2) Holotypic female, ventral view (no. 3351). (3) Holotypic female, dorsal view (no. 3351). (4) Allotypic male, ventral view of tenth and eleventh trunk zonite (no. 3352). (5) Allotypic male, dorsal view of tenth and eleventh trunk zonite (no. 3352).



Figs. 6 - 7: *Zelinkaderes klepali* sp.n. Camera lucida drawings of introvert of allotype (no. 3352). (6) Ventral view. (7) Dorsal view.

posed of type 1 spinoscalids. The second and the third ring are missing (see discussion). The fourth to the sixth ring consist of type 2 spinoscalids. Both types of spinoscalids are divided into a basal part and a terminal part, with a pectinate fringe on the former. The smooth and flexible trichoscalids built up the seventh posteriormost ring (Figs 15, 16, 33, 35).

Neck (ne). The neck, an unsculptured region posterior of the introvert, appears always smooth in the light microscope (Figs. 15, 16). In SEM it is seen that the neck is divided into 16 placids, with the midventral being the broadest (Fig. 34). There is no border between the neck and the trunk and a transition is only visible in the abrupt occurrence of a special trunk sculpturing (see below).

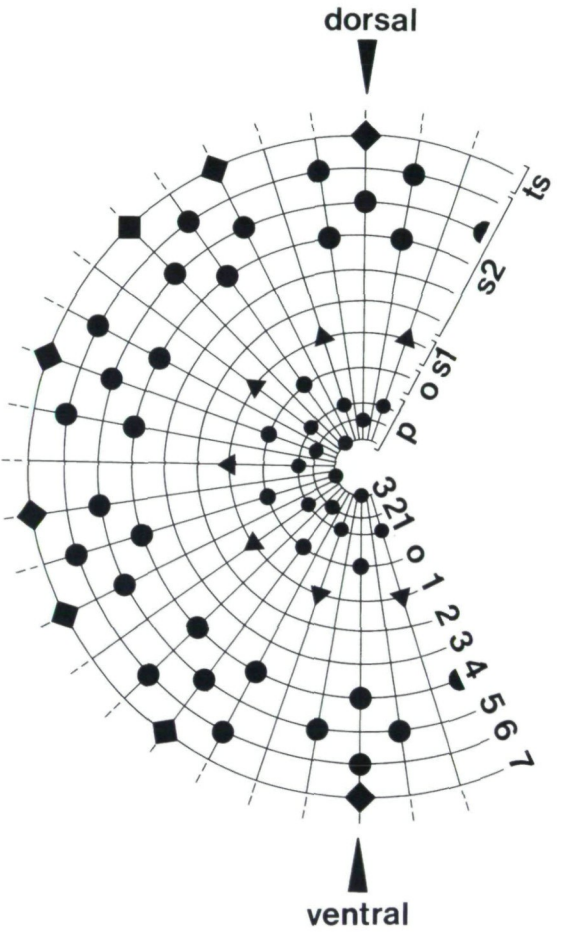
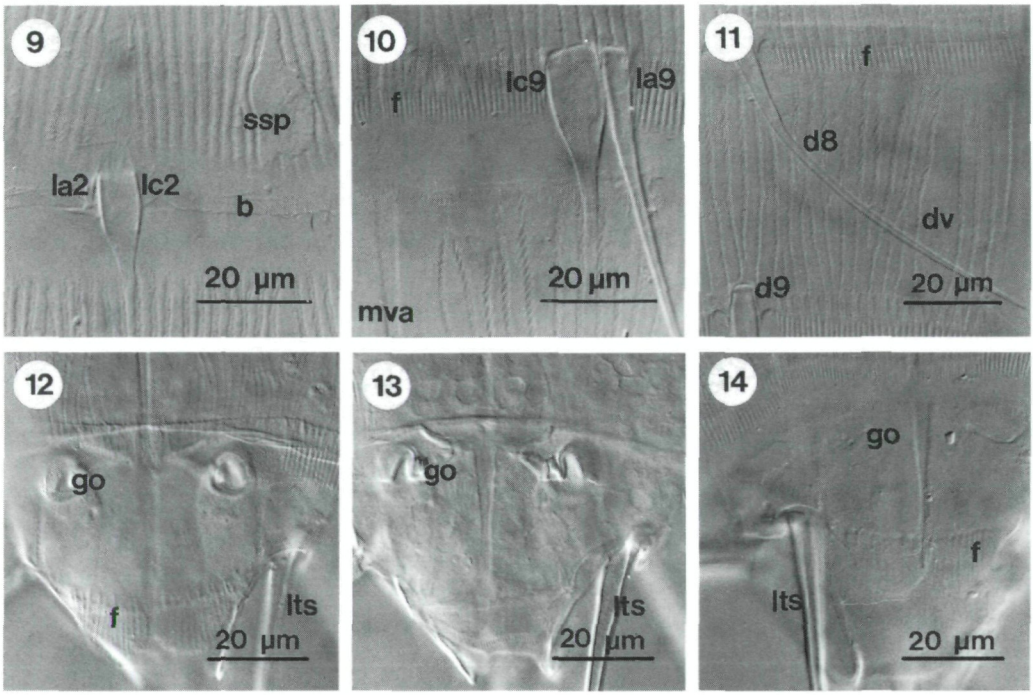


Fig. 8: *Zelinkaderes klepali* sp.n. Schematic diagram (after HIGGINS 1990) of number and arrangement of scalids, oral styles, and pharyngeal styles.

In specimens with fully inverted introvert, always the first trunk zonite creates the some kind of closure, but never the placids of the neck, which together with the introvert are withdrawn (Fig. 22).

Trunk (first to eleventh trunk zonite, z). The first and the second trunk zonite are rings without any subdivision into plates and articulations between them. The third to the tenth trunk zonite have developed a midventral articulation (Figs. 2 - 5, 21, 22). The eleventh, terminal trunk zonite additionally has one subventral and one subdorsal articulation on each lateral side, which longitudinally divides the zonite into two ventral, two lateral, and one dorsal plate (Fig. 27). Each midventral articulations is characterized by a small longitudinal, midventral slit separating the two edges of the articulation zone. Adjoining the midventral articulation there is a bristle-free area anteriorly, which presumably is the appendage of the dorsoventral musculature. Posteriorly, a hirsute region follows, built up by simple, short cuticular bristles (Figs. 10, 31).



Figs. 9 - 14: *Zelinkaderes klepali* sp.n. Light microscopical photographs with interference contrast of whole mounts. (9) Lateral spines and dorsolateral sensory spot of second trunk zonite; note the posterior border which is built up by unregularly cuticular bristles (no. 3353). (10) Lateral terminal spines of ninth trunk zonite (no. 3352). (11) Middorsal spines of eighth and ninth trunk zonite; note sculpture of the dorsal plate (no. 3352). (12) Tenth and eleventh trunk zonite of female with gonopores, ventral view (no. 3354). (13) Tenth and eleventh trunk zonite of female with canals of gonopores, ventral view (no. 3354). (14) Tenth and eleventh trunk zonite of male with presumable gonopores, ventral view (no. 3357).

Except for the first trunk zonite, which has no anterior border (Fig. 34), all other trunk zonites show a simple, straight, anterior border without any thickenings extending into the interior of the animal (pachycycli) (Figs. 9 - 11). The posterior border is also simple from the first to the third trunk zonite, with cuticular bristles randomly present on the border, few in the first and several in the third trunk zonite (Figs. 9, 23). The fourth to the tenth trunk zonites have developed a pectinate fringe, interrupted only by the middorsal and lateral spines, and by the midventral articulations (Figs. 10, 11, 23, 24). In the terminal trunk zonite a pectinate fringe only occurs at the ventral plates (Figs 12, 14).

The sculpturing of the trunk is a very conspicuous character in *Zelinkaderes klepali*. In the light microscope the animals appear striated (Figs. 9 - 11), whereas it is visible in SEM that longitudinal rows are composed of small, bifid cuticular bristles (Figs. 23, 24). These rows are only interrupted by sensory spots, by paired dorsally lying, hirsute areas, and by hirsute areas adjoining the midventral articulation (Fig. 32). The ventral and the dorsal plates of the terminal trunk zonite are also covered with simple, short cuticular bristles; the lateral plates are smooth and nonhirsute (Figs. 25 - 27).

Table 1. *Zelinkaderes klepali* sp.n. Mean ($\bar{x}$) and standard deviation (δ) of length measurements (in µm) of various morphological characters in ten females and ten males. The total length is measured from the midventral trichoscalid to the end of the terminal trunk zonite.

character	total (n = 20)		females (n = 10)		males (n = 10)	
	$\bar{x}$	δ	$\bar{x}$	δ	$\bar{x}$	δ
total length	598.0	30.5	603.7	27.8	590.6	34.5
ne + z1	58.0	6.5	61.0	2.1	54.7	19.4
z2	54.7	7.8	54.6	8.3	54.9	16.6
z3	50.9	5.5	51.7	6.5	50.2	15.2
z4	50.7	5.2	49.0	4.7	52.4	15.8
z5	56.2	5.9	54.6	4.6	57.8	17.7
z6	61.5	4.3	61.3	4.8	61.7	19.1
z7	65.8	5.5	66.9	3.6	64.7	20.6
z8	70.7	5.8	72.8	4.9	68.6	21.7
z9	73.6	6.0	74.3	7.4	72.8	22.3
z10	68.0	9.6	69.9	12.2	66.2	19.0
z11	53.2	9.7	56.3	9.9	49.7	15.7
al2	12.4	0.8	12.7	0.9	12.1	4.3
al8	75.3	6.7	74.8	6.0	75.8	23.2
al9	83.3	9.6	79.7	5.9	86.8	26.4
al10	65.9	7.9	68.4	4.9	63.1	21.1
cl2	25.6	2.6	26.6	3.0	24.6	7.4
cl5	30.0	2.8	30.3	2.3	29.8	9.2
cl8	33.9	2.3	34.2	2.2	33.7	10.3
cl9	34.2	2.5	34.6	2.2	33.9	10.8
lts	149.4	12.5	144.6	8.2	155.3	49.5
ltas	99.6	5.5	99.6	5.7	99.5	31.4
d4	71.5	6.2	70.6	4.8	72.4	22.8
d6	80.8	4.7	80.2	3.1	81.5	26.1
d8	88.9	7.6	86.6	7.3	91.6	27.9
d9	93.6	7.6	96.2	6.6	90.7	29.7
d10	88.6	14.9	102.8	6.5	75.8	27.4
d11	286.2	73.1	291.5	96.9	278.7	105.4
mts	540.5	29.0	523.5	13.7	549.9	192.0
pharynx	104.2	13.7	110.3	8.0	86.1	40.6

Lateral spines (la, lc). Two different types of lateral spines (acicular and cuspidate) are present on each ventrolateral side of the trunk, thus being bilateral symmetrically arranged. Acicular spines (la) occur on the second, fifth, eighth, ninth, and tenth trunk zonite; cuspidate spines (lc) occur on the second, eighth, and ninth trunk zonite (Figs. 2 - 5). On the second and the eighth trunk zonite the acicular spine is positioned more mesially adjoining the cuspidate spine (Figs. 9, 24), whereas it is more laterally on the ninth trunk zonite (Fig. 10). The cuspidate spines increase in length from anterior to posterior. The acicular spines l2, l8 and l9 also increase in length, but l10 is shorter than l8 (Table 1). Both types of lateral spines are hirsute. A prominent pore is visible on the tip of each cuspidate spine (Fig. 24).

Middorsal spines (d). Middorsal spines lie at the posterior edge of the fourth, sixth, and eight to eleventh trunk zonites (Figs. 2 - 5). They are hirsute and bordered by a small indentation on each side (Figs. 11, 23). The middorsal spines increase in length from anterior to posterior, except for d10 in males, which is much shorter than d8 and d9 (Table 1).

Terminal spines (lts, ltas, mts). The lateral terminal spines lie more mesioventral to the lateral terminal accessory spines and are longer and thinner than the latter. Both lateral spines lie on the lateral cuticular plates, whereas the longest midterminal spine is a formation of the dorsal cuticular plate (Table 1; Figs. 2 - 5). The terminal spines are hirsute similar to the middorsal and lateral spines (Figs. 25 - 27).

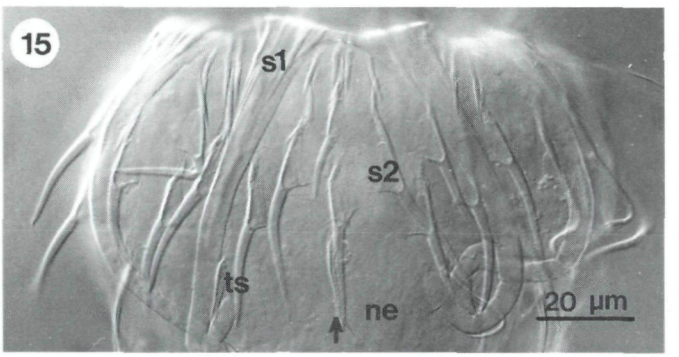
Sensory Spots (ssp, mssp). Except for an unpaired sensory spot middorsally on the second trunk zonite in the same position as the middorsal spines (Fig. 23), all others are paired and bilateral symmetrically arranged: ventrally on the ninth, tenth, and eleventh trunk zonite, mesially to the lateral spines viz. lateral terminal and lateral terminal accessory spines; dorsolaterally on the second, fourth, sixth, and seventh trunk zonite in the same position as the lateral spines; dorsally on the tenth trunk zonite (Figs. 2 - 5). Two pairs of sensory spots are present one behind the other on the eleventh trunk zonite, with the posterior one being extremely small (Fig. 27, asterisks), followed by one pair of modified sensory spots adjacent the midterminal spine (Fig. 29). In most sensory spots two pores are present (Fig. 30).

Foregut. The mouth opening (Fig. 37) terminally on the mouth cone is bordered by nine decamerous arranged oral styles (the tenth, dorsal one is missing) (Figs. 8, 17, 18, 23). All oral styles consist of two elements with lateral wings and a pectinate fringe on the basal part (Figs. 20, 38). On the buccal epithelium of the mouthcone three rings of pharyngeal styles with 10, 5, and 5 styles from anterior to posterior are developed (Fig. 20). The first ring consists of five pairs of pharyngeal styles, all of them having a basal, hirsute part, and a terminal spine-like part. The second ring is composed of large, strongly cuticularized, hook-shaped pharyngeal styles. The five pharyngeal styles of the third ring are again bipartite, both of them being smooth and unsculptured. All pharyngeal styles have a pore in their tips (Figs. 20, 36, 39).

The buccal cavity is followed by a pear-shaped pharyngeal bulb with a presumably pharyngeal crown on its anterior end (Fig. 19).

Sexual dimorphistic characters. Females of *Zelinkaderes klepali* have developed strongly cuticularized gonopores on the ventral plates of the terminal zonite (Figs. 12, 13, 28), whereas the same area is only weakly sculptured in males (Fig. 14). Although no openings could be ascertained in this area in males, it is assumed to be the outlets of the gonads. The lateral and dorsal spines of the tenth trunk zonite are curved in males (Figs. 26, 27), whereas they are straight in females (Fig. 25).

Figs 15 - 20: *Zelinkaderes klepali* sp.n. Light microscopical photographs with interference contrast of whole mounts. (15) Introvert with scalids, ventral view (no. 3352). (16) Introvert with scalids, dorsal view (no. 3352). (17) Mouth cone with oral styles (no. 3356). (18) Mouth cone with mouth opening (no. 3356). (19) Pharyngeal bulb with pharynx crown (no. 3355). (20) Oral styles (arrow points to articulation) and three rings of pharyngeal styles; specimen with everted buccal cavity due to treatment with freshwater (no. 3358).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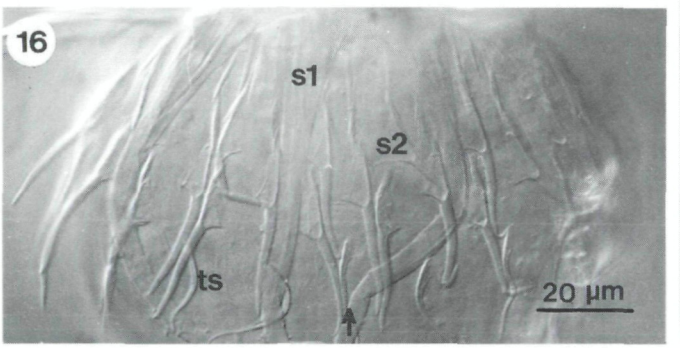
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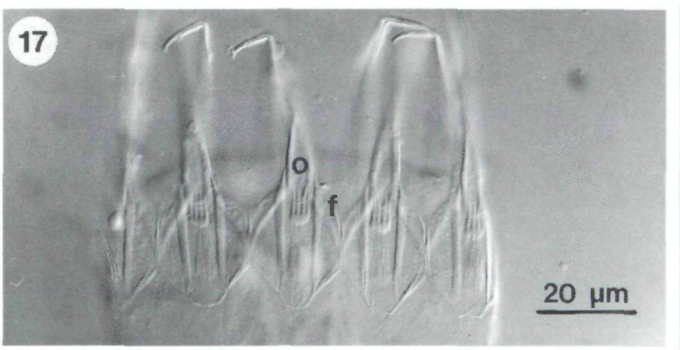
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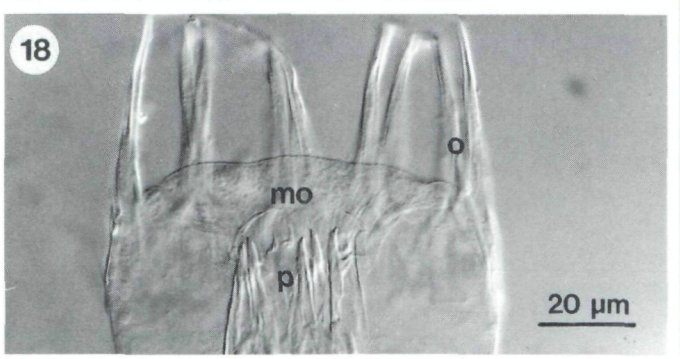
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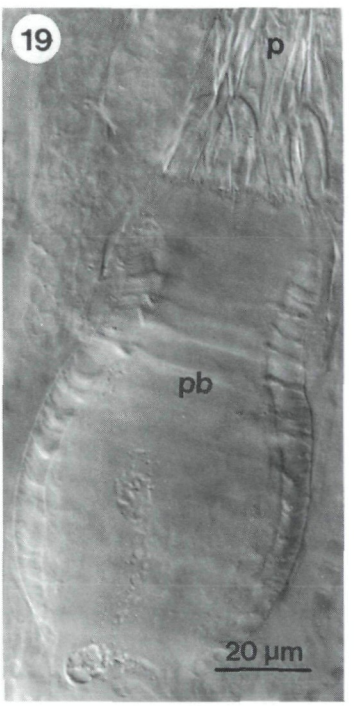
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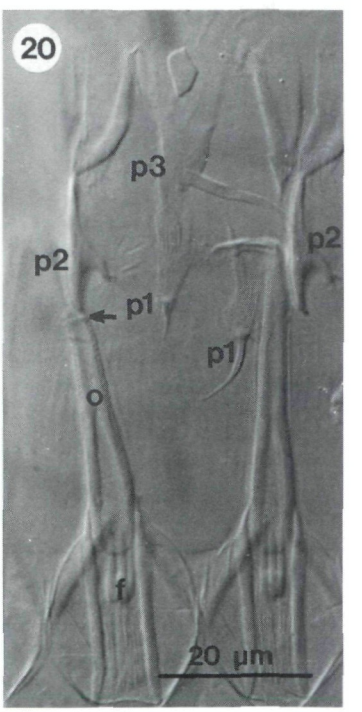
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Fine structure of the cuticle. As in all other investigated kinorhynchs so far, four different cuticular layers can be differentiated, a triple-layered epicuticle, apically, a homogeneous, sometimes laminate, e-dense intracuticle, and either a homogeneous e-translucent procuticle or a fibrillar e-translucent procuticle basally (see nomenclature KRISTENSEN & HIGGINS 1991, NEBELSICK 1993). Fundamentally, the difference between flexible and more rigid cuticle lies in the occurrence of either a fibrillar procuticle in the former type or a homogeneous procuticle in the latter. This division is also valid for *Zelinkaderes klepali*, where flexible cuticle is present in the introvert, the mouth cone, the neck, the cuticle connecting the trunk zonites, and the midventral articulation sites of the trunk (Figs. 40, 41). Ultrastructurally there is no difference between the placids of the neck and the connecting areas in between. This corresponds to the light microscopical picture, where it is impossible to distinguish the placids of the neck. Nevertheless, the cuticle of the neck has the ability to fold into placids, as seen in SEM (Figs. 34, 41).

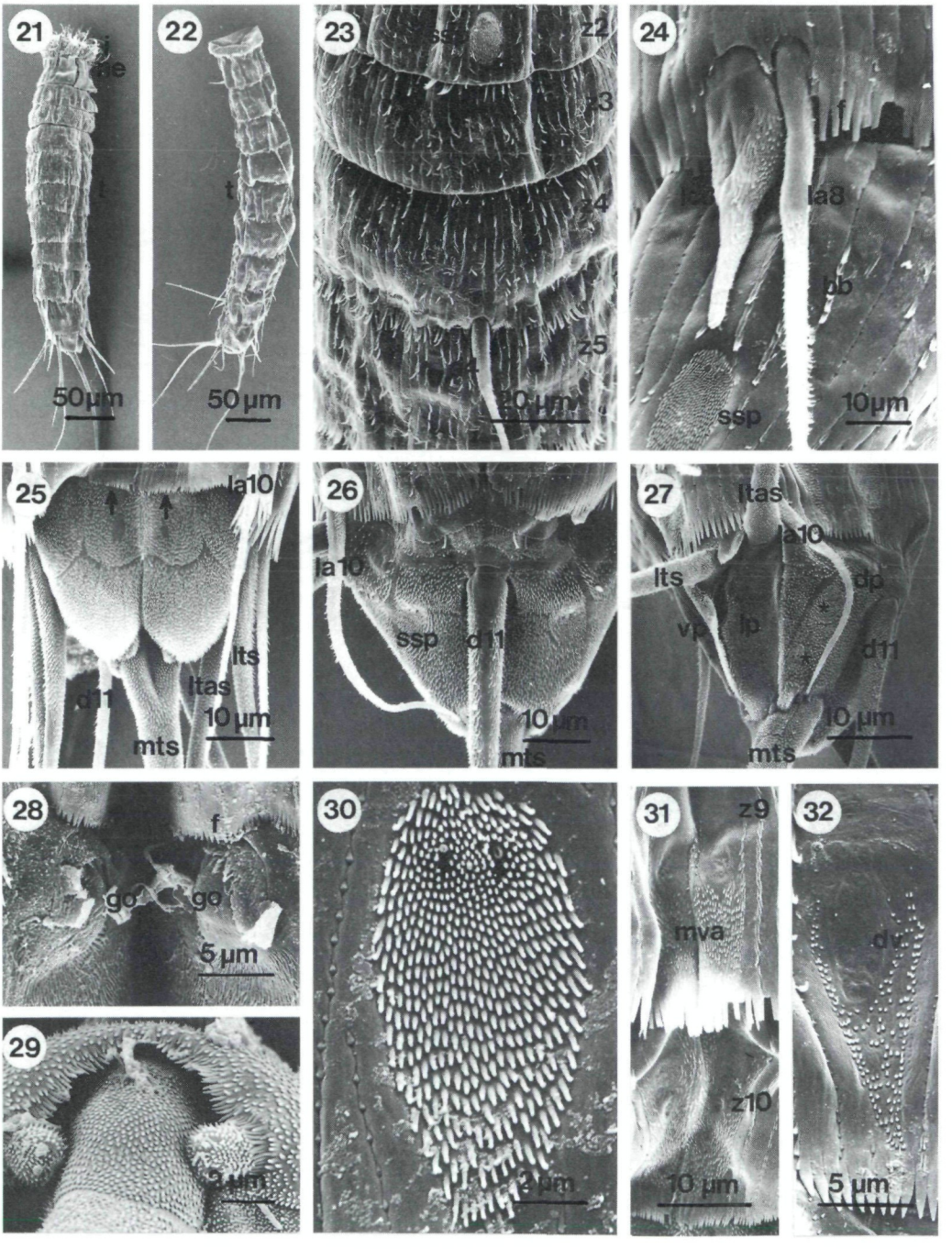
More rigid cuticle is only developed in parts of the scalids, the oral and pharyngeal styles, and the trunk spines. In this species, however, the intracuticle is hardly distinguishable from the homogeneous procuticle (Fig. 43).

The cuticle of the trunk is interpreted as moderate flexible, where in between an epicuticle and a basal fibrillar procuticle longitudinal, trapezoid rows of intracuticle alternate with areas of homogeneous procuticle (Fig. 42). These rows are also indicated in LM a distinct striation (Figs. 9 - 11) and in SEM as the origin of the bifid cuticular bristles (Figs. 23, 24). The midventral articulation is broader than the trapezoid rows, but has the same fine structural organization of a flexible cuticle.

Discussion

With the description of *Zelinkaderes klepali*, the third species of this recently described genus is provided. All representatives occur in subtidal mesopsammon: *Z. floridensis* HIGGINS, 1990, has been found in muddy sands, in 140 m depth of the Atlantic Ocean, east of Florida; *Z. submersus* (GERLACH, 1969) in medium sand, in 30 m depth of the North Sea (GERLACH 1969, HIGGINS 1990); and *Z. klepali* sp.n. in shallow water sands of the Red Sea (this publication).

Figs 21 - 32: *Zelinkaderes klepali* sp.n. Scanning electron microscopical photographs. (21) Total lateral view of female with everted introvert. (22) Total lateral view of male with inverted introvert. (23) Dorsal view of sensory spot (second trunk zonite) and middorsal spine (fourth trunk zonite). (24) Ventral view of lateral cuspidate and acicular spines (ninth trunk zonite) and sensory spot (tenth trunk zonite). (25) Ventral view of terminal trunk zonite; arrows point to gonopores, which are underneath the pectinate fringe of the tenth trunk zonite. (26) Dorsal view of terminal trunk zonite (d10 is broken). (27) Lateral view of terminal trunk zonite; note hirsute dorsal and ventral plates and unsculptured lateral plate; asterisks point to sensory spots. (28) Gonopores in female on terminal trunk zonite. (29) Modified sensory spots adjacent midterminal spine. (30) Sensory spot with two pores. (31) Midventral articulation of ninth and tenth trunk zonite. (32) Bilateral symmetric sculpture of dorsal plate.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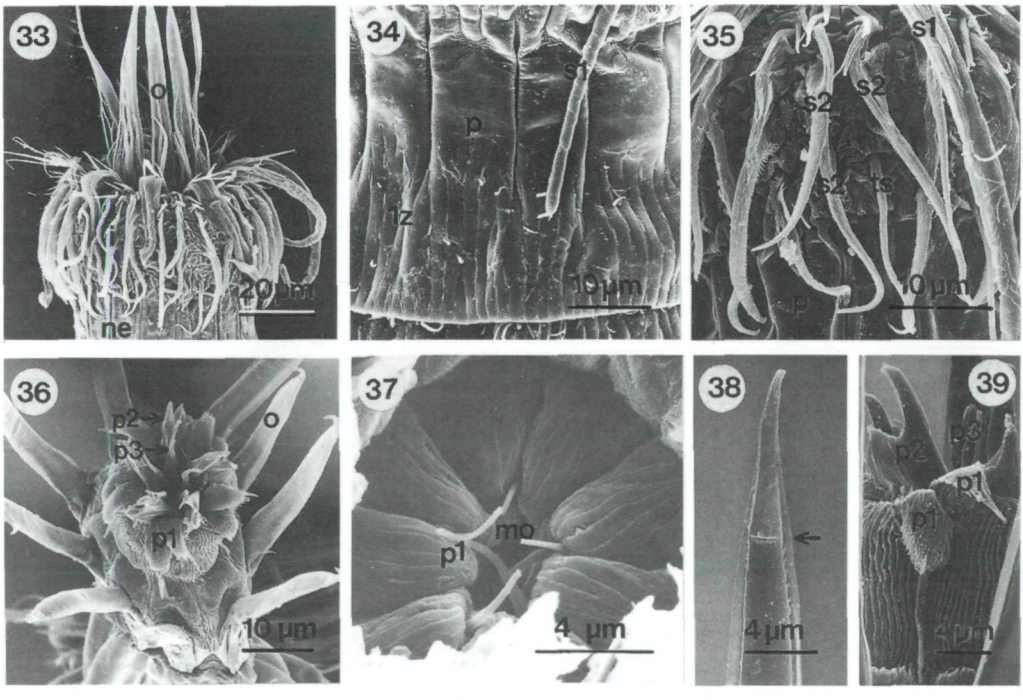
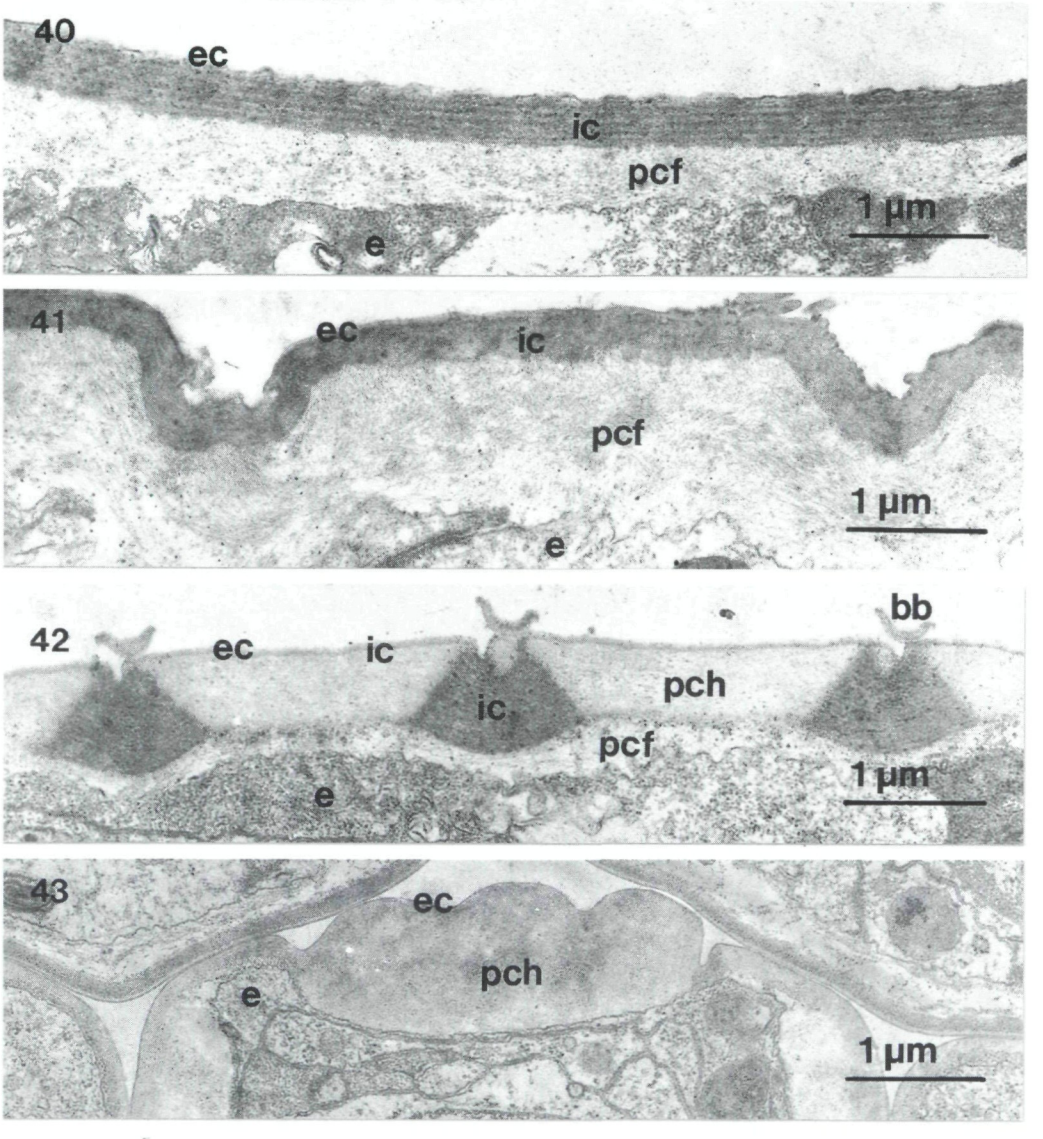


Figs 33 - 39: *Zelinkaderes klepali* sp.n. Scanning electron microscopical photographs. (33) Introvert and neck. (34) Neck with placids. (35) Scalids. (36) Mouth cone; specimen with partly everted buccal cavity due to treatment with freshwater. (37) Mouth opening closed by buccal epithelium; note terminal parts of pharyngeal styles (p1). (38) Terminal articulation of oral style. (39) Pharyngeal styles; specimen with partly everted buccal cavity due to treatment with freshwater.

The study of the introvert scalids in *Zelinkaderes klepali* and a comparison with other kinorhynchs (BROWN 1989, KRISTENSEN & HIGGINS 1991, NEBELSICK 1993) reveals exactly the same number and scalid arrangement, known for *Echinoderes capitatus* (ZELINKA, 1928), *Kinorhynchus phyllotropis* BROWN & HIGGINS, 1983, and *Pycnophyes greenlandicus* HIGGINS & KRISTENSEN, 1988, except for the second and third ring of type 2 spinoscalids, which lack in *Z. klepali*. Despite the fact that HIGGINS (1990) did not find the same arrangement of scalids in *Z. floridensis*, which may be due to different interpretation, the most conspicuous finding is the different number of total scalids. Whereas in *Z. klepali* 69 scalids are present, only 54 scalids are found in *Z. floridensis*. Since this is the first time that data are available which allow a comparison within one genus, it seems that in *Zelinkaderes* the number and arrangement of scalids are not genus specific characters.

The neck of all representatives of *Zelinkaderes* is composed of 16 weakly developed placids, which are not distinctly separated from the trunk. In *Z. klepali* it does not constitute the closing apparatus, nor is it seen to participate in a protectorial function, as it will completely inverted together with the introvert. The same is true for the first trunk zonite, which then builds the anterior end. Because the representatives of *Zelinkaderes* and



Figs 40 - 43: *Zelinkaderes klepali* sp. n. Transmission electron microscopical photographs. (40) Flexible cuticle of introvert. (41) Flexible cuticle of neck. (42) Moderate flexible cuticle of the trunk. (43) Rigid cuticle of type 2 spinoscalids.

Cateria GERLACH, 1956, lack a strongly cuticularized armour, it is not surprising that a closing apparatus is missing as well (GERLACH 1956, 1969, HIGGINS 1968, 1990)

A unique character within kinorhynchs is the terminal trunk zonite in *Zelinkaderes klepali*, which is divided into four cuticular plates. This peculiarity is additionally emphasized by the differently sculptured, unregularly hirsute surface.

Whereas the distribution of the middorsal spines is constant in *Zelinkaderes*, the occurrence of the lateral spines differs (HIGGINS 1990). Lateral cuspidate spines are present on the fifth, eighth, and ninth trunk zonite in all three species of this genus; they are found additionally on the second trunk zonite in *Z. floridensis*, and additionally on the second, fourth, sixth, and seventh trunk zonite in *Z. submersus*. Lateral acicular spines occur on the eighth, ninth, and tenth trunk zonite of all three species; in *Z. klepali* they are also found on the second trunk zonite. *Zelinkaderes klepali* and *Z. submersus* have in common that the lateral terminal spines are longer than the lateral terminal accessory spines.

Prominent striation of the trunk cuticle, similar to *Zelinkaderes klepali*, is also present in *Z. submersus* (GERLACH 1956: 163, Figs. 4, 6; HIGGINS 1990: 26, Figs. 77, 78). In *Z. floridensis* the striation is less distinct, viz. much closer and less regular (HIGGINS 1990: 23, Fig. 65; 1990: 17, Figs. 21 - 25; 1990:18, Figs. 27, 32). Bifid cuticular bristles, the surface indication of the underlying longitudinal, trapezoid rows of intracuticle in *Z. klepali* are also, together with single cuticular bristles, present in *Z. floridensis* (HIGGINS 1990: 17, Fig. 24). These facts seem to be indications of similar cuticular fine structure of the trunk region in all three representatives of *Zelinkaderes*. However, this has to be clarified in future TEM investigations.

Following HIGGINS (1990), *Zelinkaderes klepali* can be classified within the genus *Zelinkaderes* because of the neck consisting of 16 indistinct placids and fused with first trunk zonite; the second and third trunk zonite are complete rings; the fourth to tenth trunk zonite are provided with midventral articulations; a midterminal spine is present; middorsal spines occur on the trunk zonites four, six, eight to eleven, and cuspidate spines are present; the oral styles are bipartite. The number of scalids and their special pattern, the terminal trunk zonite in the form of four cuticular plates, and the occurrence and distribution of the lateral spines easily distinguishes *Z. klepali* from the other *Zelinkaderes* species.

Only a few investigations have dealt with the cuticular fine structure in kinorhynchs, all of them from representatives of the genera *Echinoderes* CLAPARÈDE, 1863, *Pycnophyes* ZELINKA, 1907, and *Kinorhynchus* SHEREMETEVSKIJ, 1974, provided with an armour. They all have in common tripartite trunk zonites with a dorsal and two ventral plates built up by a typical rigid cuticle (epi-, intra-, homogeneous procuticle). Due to the non-armoured overal organization in *Zelinkaderes klepali*, it is not surprising that the cuticle is structured differently. From a general functional and comparative morphological viewpoint, it became obvious that the only layer providing some kind of rigidity is the homogeneous procuticle. In all kinorhynchs it is present in the stiff parts of various appendages. Additionally, it is developed in the placids of the closing apparatus of *Echinoderes*. It is the major part of the trunk plates of *Echinoderes*, *Kinorhynchus*, and *Pycnophyes* (MORITZ & STORCH 1972, MERRIMAN & CORWIN 1973, KRISTENSEN & HIGGINS 1991, NEBELSICK 1992a, b, 1993), but plays a minor role in the formation of the trunk in *Z. klepali*. Especially it is not present in those parts of the body which must retain the possibility to distort like the introvert.

The most interesting result, however, is the difference in the fine structural organization of the midventral articulation between armoured and non-armoured kinorhynchs. It is mainly built by the fibrillar procuticle in *Kinorhynchus giganteus* (ZELINKA, 1928) (MORITZ & STORCH 1972), *Pycnophyes greenlandicus* (KRISTENSEN & HIGGINS 1991),

Echinoderes gerardi HIGGINS, 1978, and *E. capitatus* (own observations). The lack of fibers in the midventral articulation of *E. kozloffi* HIGGINS, 1977, (falsely identified as *E. dujardini* CLAPARÈDE, 1863; see HIGGINS 1977) and *E. aquilonius* HIGGINS & KRISTENSEN, 1988, may be due to inproper fixation (MERRIMAN & CORWIN 1973, KRISTENSEN & HIGGINS 1991). In contrast, in *Zelinkaderes klepali* it is mainly built by the intracuticle. The organization of the midventral articulation therefore seems to be correlated with the overall organization of the trunk cuticle, i. e. armour versus non-armour. This is one of the unresolved questions of the basic cuticular pattern of kinorhynchs (see also discussion in NEBELSICK 1990), which only can be clarified in detailed fine structural examinations of representatives of the other non-armoured and armoured taxa.

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