Acta Theriologica 38 (2): 125 – 137, 1993.
PL ISSN 0001 – 7051

New records of *Parascalops*, *Neurotrichus* and *Condylura* (*Talpinae*, *Insectivora*) from the Pliocene of Poland

Stanisław SKOCZEŃ

Skoczeń S. 1993. New records of *Parascalops*, *Neurotrichus* and *Condylura* (*Talpinae*, *Insectivora*) from the Pliocene of Poland. Acta theriol. 38: 125 – 137.

Four humeri, two from the locality of Podlesice (early Pliocene, early Ruscinian MN 14) and two from Węże 1 A (Pliocene, Ruscinian MN 15) are the basis for description of a new species of *Parascalops fossilis* sp. n. In Węże 2 (Pliocene, Ruscinian-Villanyian MN 15/16) one M^1 and one humerus of *Neurotrichus minor* sp. n. was found. Many remains of *Condylura kowalskii* Skoczeń, 1976, come from the same locality as well. A single humerus of *Neurotrichus polonicus* Skoczeń, 1980, has been found in Kielniki 3 B (late Villanyian MN 17). All the above mentioned *Talpidae* species belong to the recent North American endemic genera and appeared as single species exclusively. The problem of probable migration or development of convergent lines is discussed.

Department of Zoology and Wildlife Management, Agricultural Academy of Cracow, 29 November Allee 46, 31-425 Cracow, Poland

Key words: *Parascalops*, *Neurotrichus*, *Condylura*, *Talpinae*, Pliocene, Poland

Introduction

The first data concerning *Condylura* remains from Polish Pliocene localities (Skoczeń 1976) and *Neurotrichus* (Skoczeń 1980) has led to vivid discussion of the origin and possible migrations of North American *Talpidae* from the Old World or development of parallel or convergent lines.

The present data on fossil *Talpinae*, among them *Parascalops* also have bearing on further discussion.

The *Quyania chowi* from the upper Miocene (Upper Turolian) or lower Pliocene (Ruscinian) of inner Mongolia, described by Storch and Qiu (1983), exhibits clear phyletic relations to the genus *Neurotrichus* of the Old and New World.

The genus *Palurotrichus* Ziegler, 1985, from the Bavarian Miocene, shows features which designate it as ancestral to recent Japanese *Urotrichus*.

The results of biochemical investigations concerning the immunological relations of seven species of the recent North American moles (Yates and Greenbaum 1982) suggest that *Condylura* is of Palearctic origin.

Fossil remains of *Condylura* were known up till now exclusively from the Pleistocene of North America. Hutchison (1984) has given a description of a single humerus (c.f. *Condylura*) from the late Miocene or early Oregonian.

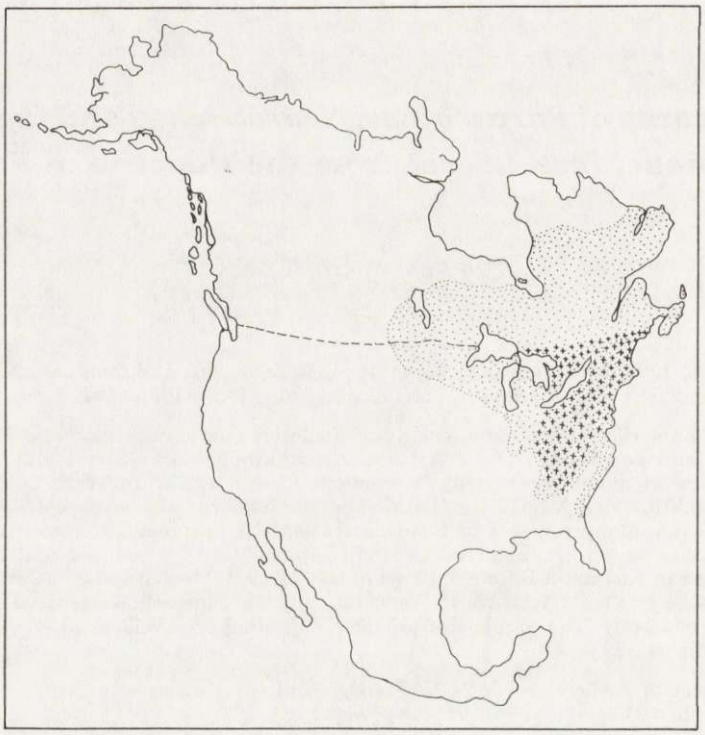

Fig. 1. The distribution of *Condylura cristata* (spoted) and *Parascalops breveri* (crossed), after True 1879, completed.

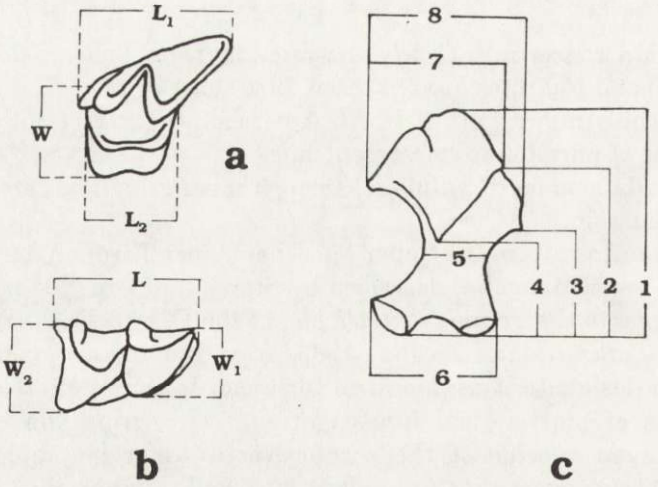

Fig. 2. Measurements: a – upper molars, b – lower molars, c – humerus, L = length, W = width, 1 – total length, 2 and 3 – tuberculus teres – proximal and distal margin distance from humeral distal edge, 4 – tuberculus pectoralis distance from the humeral distal edge, 5 – shaft width, 6 – distal width, 7 – proximal width, 8 – maximal width.

The problem of the genus *Parascalops* might be regarded in a similar way. It exists in North America in a single species, *Parascalops breweri* Bachman, 1842 ranging from southern Quebec and Ontario to central Ohio as well as southward to eastern North Carolina (Fig. 1), up to 900 m above sea level in Appalachia (Walker 1964).

Methods applied for measuring teeth and postcranial skeletal elements are given in Fig. 2. All the measurements were taken under an MST 130 microscope.

Abbreviations: MF – Institute of Systematic and Evolution of Animals in Cracow. ZPAL – Institute of Paleobiology, Polish Academy of Sciences in Warsaw.

Systematic part

Tribe: *Scalopini* Dobson, 1883
Subtribe: *Parascalopina* Hutchinson, 1968
Genus: *Parascalops* True, 1894
Species: *Parascalops fossilis* sp. n.

Derivatio nominis: the name emphasizes the fossil origin of the species.

Holotype: the nearly complete left humerus (MF/1018/24) from the Podlesice locality (Fig. 3a).

Paratypus: distal part of the right humerus (MF/1018/25) as well as manubrium sterni and right ulna from Podlesice (MF/1018/1.19), previously identified as *Scapanulus agrarius* Skoczeń, 1980.

Additional material: Two incomplete humeri, left and right (MF/1019/3.4) from Węże 1 A. The measurements of above mentioned material are given in Table 1.

Holotype description: humerus of comparatively small dimensions; length 10.7 mm, proximal width 7.7 mm, distal width 6.0 mm. Fossa brachialis shallow, clavicular articular facet separated from the head,with the cleft of the deepened fossa situated between the lesser tuberosity and tuberositas major. The head axis is parallel to the shaft axis. The scalopinae ridge is fragmentary. The trochlea touches the fossa musculi flexor digiti ligament.

Relationships: the following features prove that this Polish form is related to *Parascalops* recent:

- the trochlea touches the fossa musculi flexor digiti ligament,
- the fossa brachialis for both forms has the same triangular shape,
- the wall of the clavicular facet is flat and thin,
- the fissure separating the greater tuberosity from the head is similarly thin and subtle,
- the shape of the head for the radius is similar for both forms,
- the size and shape of the tuberculus teres are analogous to *Parascalops* recent,
- the crista pectoralis is analogically long,

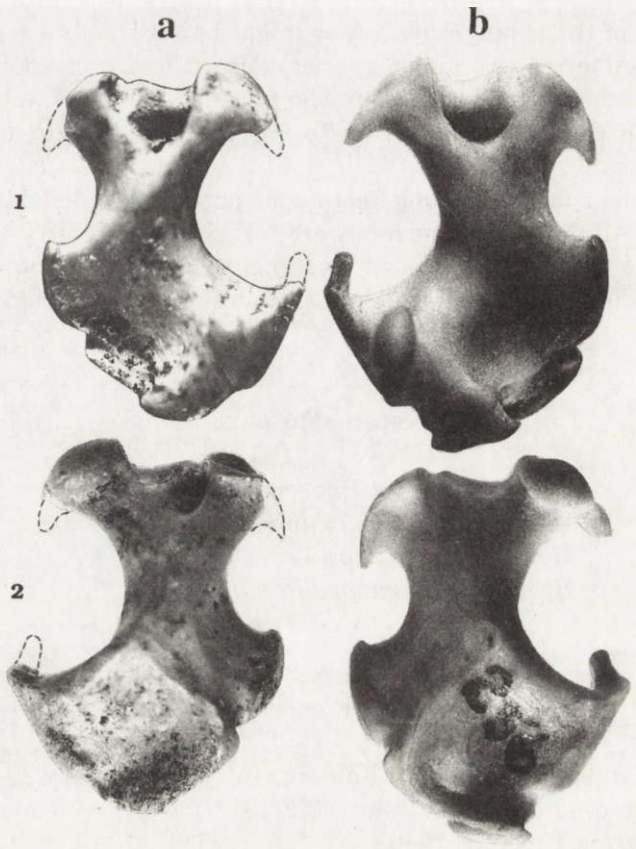

Fig. 3. Humerus of *Parascalops fossilis* sp. n. (Holotype MF/1018/24) (a) in comparison to recent *Parascalops breweri* (b). 1 – cranial, 2 – caudal views.

– the scalopinae ridge is weak and fragmentary, with a similar prominence at about half of its length,
– the position and shape of the tuberculus pectoralis is similarly proximal
– the head for scapula is significantly prominent,
– the trochlea is not higher than the edge of the fossa musculi flexor digiti ligament.

Parascalops fossilis sp. n. differs from *Parascalops* recent in the following features:
– the humerus is significantly smaller,
– the fossa brachialis is shallower,
– the lesser tuberosity is more oblique and it passes the edge of the crista pectoralis to a low degree the head axis runs outside the border of the humeral shaft,
– the vascular foramen in the halfway shaft is markedly greater.

There are the similarities between *Parascalops fossilis* sp.n. and *Proscapanus intercedens* Ziegler, 1985:
– identical shapes,

Table 1. Humerus measurements* (mm) of *Parascalops fossilis* sp. n. from the Polish Pliocene in comparison to *Parascalops breweri* and other *Scalopinae*. *See Fig. 2 for definition of measurements, ** estimated from Hutchison 1968, Fig. 11.

Measurements*	1	3	4	5	6	7	8	n
	Podlesice (MF/1018/24,25)							
Parascalops fosilis sp. n.	10.7	4.9	6.8	2.9	6.0	6.7	7.7	1
" "	–	–	–	–	6.2	–	–	1
	Węże 1 A (MF/1019/3,4)							
" "	–	4.9	–	3.4	7.0	–	–	1
" "	–	–	–	3.4	6.1	–	–	1
Parascalops breweri	12.3	5.1	7.6	3.7	7.2	7.9	8.9	1
*Scapanulus oweni***	12.3	6.0	8.0	2.5	5.7	6.2	7.5	1
Proscapanus intercendens Ziegler, 1985, middle value	10.3	–	–	2.7	6.0	–	7.1	10 – 15
Proscapanus sansaniensis (Ziegler, 1985), middle value	12.3	–	–	3.1	7.1	–	7.9	6 – 8

– the trochlea reaches the edge of the fossa musculi flexor digiti ligament,
– the head axis runs outside the shaft border as well,
– the fossa brachialis is similarly shallow,
– a fissure separating the tuberositas major from the minor is present.

Parascalops fossilis sp. n. has features which differ from *Proscapanus intercedens* Ziegler, 1985:
– a delicate and subtle morphology,
– a fine and fragmentary scalopinae ridge,
– the fissure separating the tuberositas major from minor is thin, short and straight,
– the lesser tuberosity is moved to a low degree over the edge of the crista pectoralis,
– the position of the tuberculus pectoralis is situated more proximally to the level of the tuberculus teres axis,
– the shape of the head for the radius is elliptical,
– the entepicondylus is parallel to the shaft axis,
– the trochlea is not higher than the edge of the fossa musculi flexor digiti ligament.

The following features are common to *Parascalops fossilis* sp. n. and *Scapanulus*:
– the shape of the trochlea and its connection with the fossa musculi flexor digiti ligament,
– the head for the radius has en elliptical shape,
– the ectepicondylus is connected by a broad base with the wall of the fossa musculi flexor digiti ligament,

– the fossa brachialis is similarly deep,
– the scalopinae ridge is weakly developed.

Parascalops fossilis sp. n. differs from *Scapanulus* in these ways:
– the humerus is markedly broader (the width – length ratio is 76%, and for *Scapanulus* it is about 61%),
– the teres tuberculus is shorter (28% of the humerus length; for *Scapanulus* it is about 30%),
– the tuberculus pectoralis of the fossil form from Podlesice is situated more proximally at the level of the tuberculus teres axis,
– the lesser tuberosity more weakly developed,
– the large foramen vascularis is situated at the midpoint of the shaft,
– the cavity separating the tuberositas major from minor is shallow,
– the head axis is parallel to the shaft axis,
– the crista pectoralis is longer.

The manubrium of *Parascalops fossilis* is similar to its analogue in *Parascalpos* recent in the following ways:
– the presence of a dorsal ridge, with a perforation of the wings level,
– a high ventral keel for insertion of the pectoral muscles,
– the frontal part of the keel; with a round head, is connected with the dorsal ridge,
– a broader ventral part with articular facets for the tetrahedral ossicles.

The *Parascalpos fossilis* sp. n. in manubrium differs from *Parascalops* recent in these ways:
– the head is round,
– the ventral side of the frontal part is narrower,
– the lateral profile of the frontal part of the manubrium is of rectangular shape,
– the keel bulge is stronger,
– the wings extend uniformly from the front to the back,
– perforation of the dorsal ridge is complete,
– the articular facets of the tetrahedral ossicles are larger.

The features which suggest that the ulna of *Parascalops fossilis* sp. n. is analogous to *Parascalops* recent are these:
– subtle morphology,
– a semicircularly shaped semilunar fossa,
– a similar radial articular facet,
– the terminal process and lunar articular facet are analogous,
– the vesicular foramen appears at the upper surface of the processus anconeus,
– the ratio between the length of the ulna and the length of the humerus is similar to *Parascalps* recent.

Tribe: *Urotrichini* Dobson, 1883
Genus: *Neurotrichus* Günter, 1880
Neurotrichus minor sp. n.

Derivatio nominis: the dimensions of this humerus are much smaller than its analogue in *Neurotrichus polonicus* Skoczeń, 1980.

Holotype: right humerus ZPAL/M-2/2, Type locality: Węże 2, near Częstochowa in Jurassic Upland. Type stratum: Pliocene; Ruscinian/Villanyian MN 15/16 (Nadachowski *et al.* 1989).

Paratypus: isolated left M^1 (ZPAL/M-2/1).

Holotype description: Humerus is the smallest one of all those identified so far (Table 2). It is subtle in shape but strong in construction (Fig. 4). The fossa olecrani is deeper and somewhat ovate. The tuberculus pectoral is more laterally situated and because is visible apart the shaft border (Fig. 4). The proximal and distal parts, without epicondylar wings, are of equal width (Table 2).

Paratypus description: the M^1 is the smallest one identified so far from Rębielice Królewskie 1 A, Zamkowa Dolna Cave (Skoczeń 1980). Its protoconuli are formed weakly and the metaconuli slightly stronger. The cuspidate parastyle is well formed, prominent, anteriorly protruding and connected by a weakly formed crista with the protocone. Labially it is connected with a well defined ectocingulum along the base of the paracone. The mesostyle is undivided, it extends somewhat more labially than the parastyle and metastyle, and it is continuous with a weakly developed ectocingulum along the markedly shallow postectoflexus. The meta-

Table 2. Humerus measurements* (mm) of *Neurotrichus minor* sp. n. (Węże 2) and *Neurotrichus polonicus* (Kielniki 3 B), in comparison to *Neurotrichus polonicus* from Rębielice Królewskie 1 A (Villanyian), (Skoczeń 1980). * See Fig. 2 for definitions of measurements.

Measure-ments*	Węże 2 $n = 1$	Kielniki 3 B $n = 1$	Rębielice Kr. 1 A (Skoczeń 1980) min – max	$\bar{x}$	SD
1	7.2	8.0	8.2 – 9.0 $n = 8$	8.6	0.10
2	5.2	6.0	5.8 – 6.5 $n = 12$	6.2	0.10
3	3.5	4.0	3.6 – 4.6 $n = 12$	4.2	0.13
4	3.4	4.0	3.2 – 3.8 $n = 12$	3.5	0.03
5	1.5	1.8	2.4 – 2.7 $n = 13$	2.7	0.03
6	3.6	4.2	4.0 – 4.3 $n = 7$	4.2	0.06
7	3.6	4.1	3.8 – 4.3 $n = 12$	4.2	0.03
8	4.0	4.2	4.3 – 4.9 $n = 7$	4.5	0.02

cingulum is weakly defined and at the base of the parastyle somewhat wider. The protoconus is markedly short and without cingula. The labial roots are flat, and the linqual root is elliptical in cross section. The smallest one, bulgelike, is situated more centrally.

Relationships: *Neurotrichus minor* sp. n. is related to *Quyania chowi* Storch et Qiu, 1983 in the following features:

- the dimensions of M^1 (in *Quyania chowi* the maximal length of M^1 = 2.08, but the width is between 1.4 and 1.64),
- the M^1 is triangular in shape (acute angled),
- the paraconus is very narrow and the postectoflexus is unusually shallow,
- a metacingulum is present and is connected with the metastyle,
- the ectocingulum is situated by the parastyle and the paracone bases,
- the mesostyle is undivided.

Neurotrichus minor sp. n. differs in M^1 from *Quyania chowi* as follows:

- the M^1 is markedly narrower and longer,
- the protoconus is shorter, and without a cingulum,
- the proto- and metaconuli are more weakly formed,
- the metacingulum is also weaker,

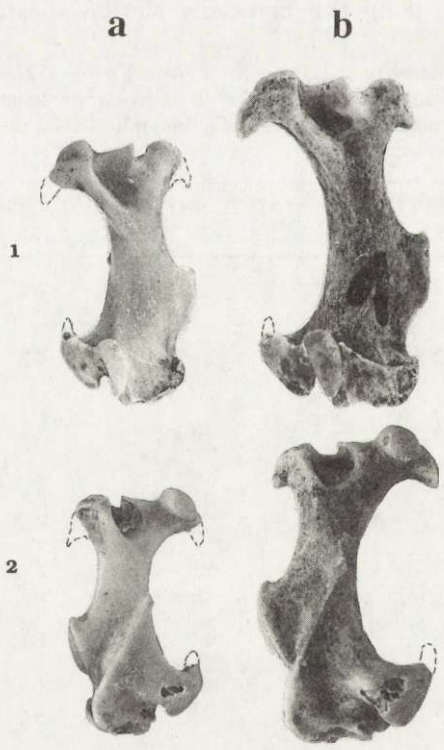

Fig. 4. Humerus of *Neurotrichus minor* sp. n. (Holotype ZPAL/M-2/2) (a) in comparison to *Neurotrichus polonicus* (b), from Rębielice Królewskie 1 A. 1 – cranial, 2 – caudal views.

– the precingulum is short and narrow,
– the parastyle is well separated and well defined,
– the ectocingulum is more weakly formed.

The following features enable us to point to morphological links between the humeri of *Neurotrichus minor* sp. n. and *Quyania chowi*:
– the dimensions (except for proximal and distal widths),
– subtle morphology,
– the shape and the depth of the fossa olecrani.
– the tuberculus pectoralis is visible from behind the shaft border as well.
– proximal and distal widths (excluding the epicondylar wings) are equal.

Neurotrichus minor sp. n. differs in humerus from *Quyania chowi* as follows:
– the border of the tuberculus teres is parallel to the shaft axis,
– the proximal and distal widths are greater,
– the scalopinae ridge is straight and runs horizontally,
– the following features distinguish *Neurotrichus minor* sp. n. from *Neurotrichus polonicus* Skoczeń, 1980:
– the M^1 is respectively longer and narrower,
– the protoconus is shorter and without a cingulum,
– the paraconus is narrower,
– the proto- and metaconuli are defined more weakly,
– the precingulum is markedly weak and short,
– the fossa olecrani is deeper and more ovate,
– the humerus is conspicuously smaller, with subtle morphology and visible adaptation to fossorial life.

The above analysis justifies designation of a new species, *Neurotrichus minor* sp. n.

Neurotrichus polonicus Skoczeń, 1980

A single right humerus (MF/1020/1), Type locality: Kielniki 3 B Jurassic Upland. Type stratum: Pliocene, late Villanyian MN 17 (Nadachowski *et al.* 1989). Smaller in size than the specimens from Rębielice Królewskie 1A (Table 2). Its rough and wounded surface indicates that a meeting with a predator took place.

Recently an interesting situation has arisen around the problem of the evolution of the palearctic genus *Neurotrichus*. Shortly after the discovery of *Neurotrichus polonicus* Skoczeń, 1980, the *Quyania chowi* Storch et Qiu, 1983 (uppermost Miocene or lower Pliocene, late Turolian or Ruscinian of inner Mongolia, China), was described (Storch and Qiu 1983).

Two years later *Palurotrichus hutchisoni* Ziegler, 1985 (middle Orleanium MN 4 to lower Astaracian MN 6) was reported (Ziegler 1985). According to Storch and Qiu (1983), *Neurotrichus polonicus* Skoczeń, 1980 would fit well morphologically in an ancestor – descendant relationship with *Quyania chowi*. Such phyletic lines should be characterized by a certain reduction of the cingulum, some enlargement of the protoconuli of the upper molars as well as some enlargement of their

Table 3. The lower teeth (M_1 – M_3) measurements (mm) of *Condylura kowalskii* from Węże 2 locality in compar- ison to the recent *Condylura cristata*. * See Fig. 2 for teeth measurements definition.

Length width*	M_1	M_2	M_3	*n*
	Condylura kowalskii – Węże 2			
L	1.6	1.7 – 1.8	1.5	5
W_1	0.9	0.8 – 0.8	0.8	5
W_2	1.0	0.9 – 0.9	0.7	5
	Condylura cristata – recent			
L	1.6	1.6 – 1.8	–	3
W_1	0.9	0.7 – 1.0	–	3
W_2	1.0	1.0	–	2

dimensions. According to the authors, the area and geological period sugest parallel evolution of *Neurotrichus polonicus* and *Neurotrichus gibbsi* from the ancestor of the *Quyania chowi*. *Neurotrichus polonicus* seems more progressive than *Neurotrichus gibbsi* concerning features such as the well defined protoconula, the reduced precingulid in the M^1 and comparatively larger dimensions.

In comparison *Neurotrichus minor* sp. n. shows a clear trend towards reduction of the cingulum and narrowing of the width of M^1. The proto- and metaconulus are less strongly defined, the protoconus is comparatively short. Generally the M^1 exhibits a subtle, modern morphology but the dimensions expand rather less.

On the other hand, except for its elegance, the humerus is characterized by a distinct adaptation to fossorial life.

Discovery of *Palurotrichus* (Ziegler 1985) confirms earlier opinions (Storch and Qiu 1983) that the *Urotrichini* of the Old World belong to another phyletical line. The *Palurotrichus* includes features of *Urotrichus*, *Neurotrichus* and *Scaptonyx* in the morphology of the humerus and teeth.

Tribe: *Condylurini* Dobson, 1883
Genus: *Condylura* Illiger, 1811
Condylura kowalskii Skoczeń, 1976

Material: M_1 from Węże 2 (ZPAL/M-1/501) and 4 incomplete mandibles (ZPAL/M-502-505), two with M_2 and M_3 *in situ*, and 23 humeri (ZPAL/M--1/506-528). Lower teeth measurements are given in Table 3.

The height and thickness values of the three mandibles (No 502 – 504) in M_2 range from 1.7 to 1.8 × 0.8 mm. The value from recent *Condylura cristata* is 2.2 × 1.3 mm.

From the above data it can be seen (Table 3) that the M_1 from Węże 2 is identical with an analogue from Rębielice Królewskie 1 A (Skoczeń 1976) but also

Table 4. *Condylura kowalskii* – measurements (mm) of the humeri from Węże 2 in comparison to materials from Rębielice Królewskie 1 A (Skoczeń 1976).

Meas.	*n*	min – max	$\bar{x}$	SD
		Węże 2		
1	5	10.6 – 11.4	11.02	0.08
2	15	7.5 – 8.6	8.12	0.21
3	21	5.8 – 7.3	6.37	0.13
4	20	4.4 – 5.3	4.88	0.12
5	22	2.3 – 2.8	2.42	0.04
6	19	4.9 – 5.9	5.50	0.06
		Rębielice Królewskie 1 A		
1	9	10.6 – 11.8	11.25	0.24
2	11	7.9 – 8.1	8.39	0.07
3	13	6.3 – 7.2	6.75	0.11
4	15	4.6 – 5.6	5.05	0.08
5	16	2.3 – 2.6	2.46	0.02
6	13	5.1 – 6.0	5.65	0.01

with recent *Condylura cristata*. The second M_2 is the longest among all these found so far.

The dimensions of 23 humeri (12 left) are given in Table 4. This almost perfect left-right ratio indicates that the moles come from a limited area and a comparatively short period of time. The interesting differences in the distance of the tuberculus teres and the pectoralis from the distal edge of humerus (Figs 5 and 6) seem to be connected with gender.

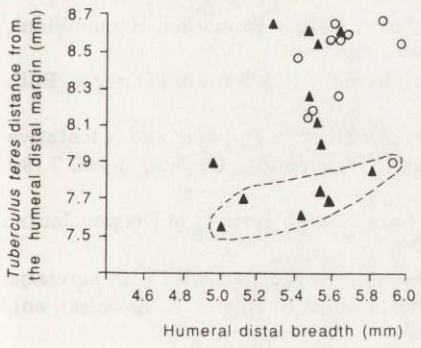

Fig. 5. *Tuberculus teres* distance from the distal humeral margin of the *Condylura kowalskii*: ○ – Rębielice Królewskie 1 A, ▲ – Węże 2 localities.

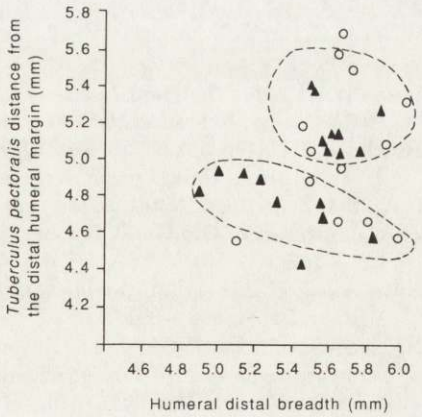

Fig. 6. *Tuberculus pectoralis* distance from the distal humeral margin of the *Condylura kowalskii*: ○ – Rębielice Królewskie 1 A, ▲ – Węże 2 localities.

The discussed material may be regarded as another confirmation that, in the Pliocene, Polish *Condylura* appeared as a relatively common mole in the area of the Jura Krakowsko-Częstochowska Upland.

The humeri of *Condylura kowalskii* from Węże 2 have much different dimensions from the collection from Rębielice Królewskie 1 A locality (Table 4). Both this localities are approximately the same geological age (lower Ruscinian, upper Villanyian).

As far as the origin of the *Condylura* is concerned, finding and describing of a single humerus (cf. *Condylura*) from Pliocene or late Miocene of Oregon by Hutchison (1984), was an important fact.

The genus *Achlyoscapter* may be regarded as the ancestor of *Condylura* (Hutchison 1968). *Achlyoscapter* is well known from the middle Miocene (Barstowian) of Oregon and from late Miocene (Hemphillian of Nebraska, Bown 1980). In their generally primitive features, the teeth and mandibles of *Achlyo- scapter* are similar to their analogues in *Condylura*. According to Hutchison (1968), there is no form in Europe which could stand as an ancestor of *Condylura*.

Yates and Greenbaum (1982) proved the almost complete isolation of *Condylura* compared to other species of American moles. The conclusion is that its divergence from the common stock took place in very remote geological periods. The authors state that *Condylura* expanded from Europe to North America in the late Pliocene or early Pleistocene. It is worth pointing out that this genus existed in the Polish Pliocene in two species (Skoczeń 1976).

Acknowledgements: I am grateful to my collegues, Prof K. Kowalski and Prof Z. Pucek, and anonymous reviewers for critical reading of earlier drafts of this paper. I wish to express my appreciation to dr A. Sulimski who provided interesting material for this study, and Miss E. Białczyk for her graphic work and typing of the text.

References

Bown T. M. 1980. The fossil *Insectivora* of Lemoyne Quarry (Ash Hollow Formation, Hemphillian), Keith County, Nebraska. Nebraska Acad. Sci. Trans. 8: 99 – 122.

Hutchison J. H. 1968. Fossil *Talpidae* (*Insectivora, Mammalia*) from the late Tertiary of Oregon. Bull. Mus. Nat. Hist. Univ. Oregon, Eugene, 11: 1 – 177.

Hutchison J. H. 1974. Notes on the type specimens of European Miocene *Talpidae* and a tentative classification of Old World Tertiary *Talpidae* (*Insectivora, Mammalia*). Geobios, Lyon, 7 (3): 211 – 256.

Hutchison J. H. 1984. Cf. *Condylura* (*Mammalia*: *Talpidae*) from the late Tertiary of Oregon. Journ. Vertebr. Pal. 4: 600 – 601.

Nadachowski A., Pawłowski J. and Stworzewicz E. 1989. Charakterystyka stanowisk i ich korelacja stratygraficzna. [In: History and Evolution of the Terrestrial Fauna of Poland. K. Kowalski, ed]. Folia Quaternaria 59 – 60: 5 – 19.

Skoczeń S. 1976. *Condylurini* Dobson 1883 (*Insectivora, Mammalia*) in the Pliocene of Poland. Acta zool. crac. 21, 8: 291 – 313.

Skoczeń S. 1980. *Scaptonychini* van Vallen, 1967, *Urotrichini* and *Scalopini* Dobson 1883 (*Insectivora, Mammalia*) in the Pliocene and Pleistocene of Poland. Acta zool. crac. 24: 411 – 448.

Storch G. and Qiu Z. 1983. The neogene mammalian faunas of Erteme and Harr Obo in Inner Mongolia (Nei Mongol), China. – 2. Moles – *Insectivora*: *Talpidae*. Senckenbergiana lethaea 64: 89 – 127.

True F. W. 1897. A revision of the American moles. Proc. U. S. Nat. Mus., Washington 19: 1 – 120.

Yates T. L. and Greenbaum I. F. 1982. Biochemical systematics of North American Moles (*Insectivora*, *Talpidae*). J. Mammal. 63: 368 – 374.

Walker E. P. 1964. Mammals of the World. V. I. J. Hopkins Press, Baltimore: 1 – 646.

Ziegler R. 1985. Talpiden (*Mammalia*, *Insectivora*) aus dem Orleanium und Astaracium Bayerns. Mitt. Bayer. Staatsslg. Paläont. Hist. Geol. 25: 131 – 175.

Received 28 October 1992, accepted 15 February 1993.