NUMERICAL IDENTIFICATION OF TEETH IN JAPANESE 
SHREW-MOLES, UROTRICHUS TALPOIDES AND 
DYMECODON PILIROSTRIS

BY

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ABSTRACT

Numerical determination of the teeth of two species of Japanese shrew-moles, *Urotrichus talpoides* and *Dymecodon pilirostris* (Talpidae, Insectivora), was based on the position of the premaxillo-maxillary suture, comparison of the dentitions of the two species with those of their relatives and the supernumerary tooth.

The premaxillo-maxillary suture is situated between the fifth and sixth tooth anterior to the M1, and the fifth tooth anterior to the M1 was determined to be C both in the two species. The supernumerary tooth which appears in the gap between the third and fourth tooth anterior to the M1 of the lower jaw of *Urotrichus talpoides* was considered as a relic of pdl which seems to have been lost relatively recently in the evolution of this species. It was also shown that the first premolar of the upper jaw of the *Urotrichus talpoides* and the first premolars of the *Dymecodon pilirostris* are dihyodont. Retention of the dihyodont first premolars in these species seems to be a primitive character and is significant in determining the phylogenetical positions of these species.

INTRODUCTION

Some species of the Talpidae retain the hypothetically primitive eutherian dental complement (I 3/3, C 1/1, P 4/4, M 3/3), and others including the two species of Japanese shrew-moles, *Urotrichus talpoides* Temminck and *Dymecodon pilirostris* True, show some reduction from this primitive complement. Although the dentitions of these two species of Japanese shrew-moles have long been studied by many authors, there is no general agreement on which teeth were lost in these species (Leche,1) Thomas,2-4 Imaizumi,5 Wilson,6 Usuki7). Recently Ziegler8) presented the following dental formulae on the basis that the un-replaced antemolar possessed by many placentals always occupied the ancestral eutherian first premolar position, without confining the premaxillo-maxillary suture:

\[
\begin{array}{cccccc}
\text{id} & 1 & 2 & 3 & \text{cd} & 1 & \text{pd} & 1 & - & ? & 3 & 4 \\
& \text{id} & - & ? & 2 & 3 & \text{cd} & - & ? & \text{pd} & 1 & - & ? & 3 & 4 \\
\text{id} & 1 & 2 & 3 & \text{cd} & 1 & \text{pd} & 1 & - & ? & 3 & 4 \\
Dymecodon*2 & 1 & - & ? & 2 & 3 & 3 & C & 1 & P & - & ? & 3 & 4 \\
& \text{id} & - & ? & 2 & 3 & \text{cd} & 1 & \text{pd} & 1 & - & ? & 3 & 4 \\
\end{array}
\]

Comparing these dental formulae with those of the American Talpidae, Ziegler8)
suggested that the differences in the tooth loss patterns between the New World Talpidae and Japanese Urotichini might mean a relatively great degree of phylogenetical differentiation between these two groups. On the other hand, Campbell, Wilson and Hutchison suggested a close phylogenetic affinity between the two groups.

The authors found that the first premolar of upper jaw of the Urotichus and the first premolars of the Dymecodon are dihyodont, while the lower first premolar of the Urotichus had been lost phylogenetically recently and that the antemolars of the Urotichus talpoides and Dymecodon pilirostris which Ziegler contended as the first premolars are the second premolars. The purpose of this paper is to determine the dental formulae of the two species of Japanese shrew-moles based on the new data obtained from many specimens of these species. Moreover, after presenting the authors’ interpretation of the dental formulae of these species, the authors will speculate on the significance of these formulae in the possible phylogenetical relationship between the American and Japanese shrew-moles.

Materials and Methods

A series of 417 skulls of the Urotichus talpoides which were collected in the city of Nagaoka, Niigata Prefecture, from November 1966 through October 1967 by the senior author and 700 of the same species preserved in the National Science Museum in Tokyo and a series of 79 skulls of the Dymecodon pilirostris collected at the foot of Mt. Fuji, Yamanashi Prefecture, from 1971 to 1973 by the senior author were made available for this study. Radiographic and low-power microscopic examinations were conducted on each specimen.

In some juvenile specimens of both the Urotichus and Dymecodon the premaxillo-maxillary suture was recognized between the fifth and sixth tooth anterior to the M1. In the anterior lower jaw of a few specimens of the juvenile Urotichus a supernumerary tooth occurred between the third and fourth dental position anterior to the M1. The antemolars of the Urotichus and Dymecodon were homologized, based on the analysis of these facts.

Results and Discussion

Upper teeth: In the 32 juvenile specimens of Urotichus talpoides an apparent premaxillo-maxillary suture was recognized (Fig. 1). These specimens retained the antemolars of the milk set and their permanent P4 had not reached the root-calciﬁcation stage in the alveolus. In the case of the Dymecodon pilirostris, in 11 juvenile specimens a premaxillo-maxillary suture was recognized markedly. Nine of them retained the full set of the milk teeth and some of the permanent P4 in the alveolus had either already reached the root-formation stage or had not. The remaining two specimens were at a replacement stage, that is, the milk teeth of the first and second dental positions anterior to the M1 of the upper jaw and the first, second and sixth dental position anterior to the M1 of the lower jaw had been shed and replaced by their successors. These differences between the two species show that the premaxillo-maxillary suture remains relatively much later in the Dymecodon than in the Urotichus. This may be related to the fact that the skull of more fossorial Urotichus is thicker than that of the Dymecodon and the fusion of the premaxillo-maxillary suture may be more accelerated in the former. The premaxillo-maxillary suture was also observed by Imaizumi in the Urotichus and Dyme-
Fig. 1. The premaxillo-maxillary suture (+) is situated between the fifth and sixth tooth, anterior to the M1 both in the Urotrichus talpoides (above) and Dymecodon pilirostris (below).

codon and by Usuki in the Urotrichus.

The premaxillo-maxillary suture was situated between the fifth and sixth tooth anterior to the M1 both in the Urotrichus and Dymecodon (Fig. 1). Therefore, the fifth tooth anterior to the M1 should be the canine, unless it is lost. Both in the Urotrichus and Dymecodon there are four antemolars between the fifth tooth anterior to the M1 and M1. Assuming that four premolars are the maximum number ever found in the Insectivora, the fifth tooth anterior to the M1 must then be considered as the canine, and the four postcanine teeth must be considered the first, second, third and fourth premolar, respectively.

Both the Urotrichus talpoides and Dymecodon pilirostris possess two antemolars anterior to the canine. As the number of the complete set of the incisor complement is three in the Insectivora, some incisors have been lost in these species. The numerical position of the lost incisor can be estimated by comparing the incisor complements of the Urotrichus and Dymecodon with those of the relatives which have a complete set of three incisors (Neurotrichus, Scapanus, Parascalops and Scalopus). In the complete set of the incisors of the these species the first incisor is the largest (often hypertrophied) and the third is the smallest (Hall and Kelson). That is, the incisors successively decrease in size anteroposteriorly. In the Urotrichus and Dymecodon the anterior incisor is larger than the other teeth. Such a difference in size is more marked in the permanent series than in the deciduous series and in the
Urotrichus than in the Dymecodon. Considering all of these things, the number of the phylogenetically lost incisor of the Urotrichus and Dymecodon might be presumed to be I3 and the anteriormost incisor and the next might be I1 and I2, respectively.

Lower teeth: The numerical position of the five antemolars (Urotrichus) and six antemolars (Dymecodon) can be determined by observing the occlusal relationship of each mandibular tooth to the other teeth of the upper jaw, by comparing the dentication of the Urotrichus with that of the Dymecodon which is congeneric with the former and by comparing the dentitions of these two species with those of the other species of the Urotrichini and its relatives.

In the Dymecodon the occlusal relationship between the first five antemolars anterior to the first molar and the fourth premolar to canine of the upper jaw are apparently recognized both in the milk series (Fig. 2) and in the permanent series,

![Image](image-url)

**Fig. 2.** The occlusal relationship of the juvenile teeth complements (milk series) of the Urotrichus talpooides (upper) and Dymecodon pilirostris (lower). The dental position of the lower jaws of the Urotrichus which meets the fourth tooth anterior to the M1 of the upper jaw, is vacant.
so that these mandibular antemolars can unquestionably be determined to be the fourth, third, second and first premolar and canine respectively. Likewise, in the *Urotrichus* the first, second and the third tooth anterior to the M1 of the lower jaw appear to meet the fourth, third and second premolar of the upper jaw, respectively, both in the milk series (Fig. 2) and in the permanent series, so that these mandibular antemolars can be determined to be the fourth, third and second premolar respectively.

The lower jaw of the *Urotrichus* lacks an antemolar which would meet the first premolar of the upper jaw and the fourth tooth anterior to the M1 of the lower jaw meets the canine of the upper jaw.

The teeth of the premolar complement of the lower jaw of *Dyemecodon pilirostris* become smaller posteroanteriorly, and the first premolar is the smallest (Fig. 3). Taking this fact and the usual anteroposterior direction of the premolar loss in the Insectivora (Kindahl[22]) into consideration, the vacant dental position in the *Urotrichus* is presumed to be the first premolar one.

An additional fact which indicates the first premolar position as the vacant one in the antemolar complement of the lower jaw of the *Urotrichus talpoides* is that a supernumerary tooth appears in the gap between the third and fourth tooth anterior to the M1 in some juvenile specimens of this species, as previously mentioned (Fig. 3). The supernumerary tooth of the *Urotrichus* is peg-like, about 1.4 mm in length (including about 0.7 mm of the root) and 0.2 mm in diameter. It was found in the three specimens of those examined by the authors (Table I) and it was consistently situated at the above-mentioned position which corresponds to the dental position of the first premolar of the *Dyemecodon* (Fig.

**Fig. 3.** The lower antemolars of the *Urotrichus talpoides* and *Dyemecodon pilirostris* and the supernumerary tooth of the lower jaw of the *Urotrichus*. A, the adult *Dyemecodon* (permanent series), B, the juvenile *Dyemecodon* (milk series), C, the supernumerary tooth of *Urotrichus*, D, the juvenile *Urotrichus* (milk series). Comparison among B, C and D shows that the supernumerary tooth of the *Urotrichus* is homologous to the fourth tooth anterior to the M1 of the *Dyemecodon*. 
### Table 1. Supernumerary Teeth Found in *Urotrichus talpoides*

<table>
<thead>
<tr>
<th>No.</th>
<th>Sex</th>
<th>Locality</th>
<th>Date</th>
<th>Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>M. 1727</td>
<td>?</td>
<td>Yokoze-Mura, Chichibu-Gun, Saitama Pref.</td>
<td>Jan. 1952</td>
<td>A gap between the third and fourth tooth anterior to the M1 of a right mandible</td>
</tr>
<tr>
<td>M. 2066</td>
<td>?</td>
<td>Sakamoto, Yokusukashi, Kanagawa Pref.</td>
<td>June 29, 1951</td>
<td>Ditto</td>
</tr>
<tr>
<td>M. 14289</td>
<td>♀</td>
<td>Yamanakako-Mura, Minamisuru-Gun, Yamanashi Pref.</td>
<td>July 6, 1937</td>
<td>A gap between the third and forth tooth anterior to the M1 of a left mandible</td>
</tr>
</tbody>
</table>

![Radiography of the lower antemolars of *Urotrichus talpoides* (upper) and *Dymecodon pilirostris* (lower) in the replacement stage. The root of the I2 of the *Urotrichus talpoides* extends to the root of P4. The tooth anterior to I2 is I2 both in the *Urotrichus* and *Dymecodon.*](image)

This fact indicates that the supernumerary tooth is a relic of the first premolar which may have been lost from this particular spot relatively recently in its evolution, rather than representing a random dental abnormality.

The supernumerary tooth seems possibly to be a milk tooth and is usually shed very early, because it was found only in such specimens which retained all the teeth of the milk set except for the second premolar. Radiographic examinations of the roots of the antemolars show that in the *Dymecodon pilirostris* the root of the anteriormost procumbent tooth is relatively small without reaching the base of the first premolar, while in the *Urotrichus talpoides* the root of the anteriormost procumbent tooth is hypertrophied, extending beneath the premolars to the anterior root of the
fourth premolar (Fig. 4). The enlarging root of the anteriormost procumbent tooth of the Urotrichus apparently restricts the development of the roots of the posterior three antemolars. Such restriction of the space may have caused the first lower premolar to be lost evolutionarily in this species. A similar situation is seen in the Scalopus (Conaway and Landry\(^3\) and Ziegler\(^8\)).

The canine of the upper jaw is met by the fourth tooth anterior to the M1 in the Urotrichus talpoides and by the fifth tooth in the Dymecodon pilirostris, as previously mentioned, so that these teeth can be determined as the lower canines.

There is one well-developed tooth anterior to the canine in the lower jaw both in the Urotrichus and Dymecodon. Although no direct proof of the numerical tooth identification of this tooth has been obtained yet, comparison of the dentitions of these species with those of their relatives may give some suggestions. The Neurotrichus, Scoepanus and Parascalops possess complete incisor complements of the three teeth, among which the I2 is the largest and the I1 and I3 are mostly decreased in size. The Scalopus has hypertrophied I2 and I1 which are reduced in size and has lost the I3 (Hall and Kelson\(^11\)). There are two types of Uropsilus in regard to the incisor complement; one possesses only the I2 and the other possesses the I2 and I3. Hypertrophy of the I2 is prominent in both types and the I3 is very small, if it exists (Osgood,\(^14\) Thomas\(^11\)). These facts may make it possible to conclude that in the Urotrichini and Scalopini the I1 and I3 tend to be degenerated and lost as I2 is hypertrophied. Such a tendency is recognizable also among the other Insectivora (Ziegler\(^8\)). Therefore, it may be most possible to identify the one large incisor of the lower jaw of the Urotrichus and that of the Dymecodon as I2.

The Urotrichus talpoides and Dymecodon pilirostris replace their full complements of the antemolars, having functional milk teeth and their successors, except for the second premolars which show no evidence of replacement in either of these species. The followings are the present determination of the teeth of the Urotrichus and Dymecodon:

<table>
<thead>
<tr>
<th></th>
<th>id 1</th>
<th>2</th>
<th>cd 1</th>
<th>pd 1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urotrichus(^#3)</td>
<td>I</td>
<td>2</td>
<td>2</td>
<td>C</td>
<td>1</td>
<td>P</td>
<td>1</td>
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<table>
<thead>
<tr>
<th></th>
<th>id 1</th>
<th>2</th>
<th>cd 1</th>
<th>pd 1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dymecodon(^#3)</td>
<td>I</td>
<td>2</td>
<td>2</td>
<td>C</td>
<td>1</td>
<td>P</td>
<td>1</td>
</tr>
</tbody>
</table>

Final discussion: The Urotrichus talpoides and Dymecodon pilirostris are exceptional among the living placentalts in that they have the dihyodont first premolars. As far as it is known, the first premolars of the living placentalts are unreplaced except for the primitive perisodactyle, Tapirus (Leche,\(^1\) Eadie,\(^15\) Kindahl,\(^12\) Kubota and Togawa,\(^16\) Thomas,\(^4\) and Ziegler\(^8\)). Retention of the dihyodont first premolars in the Dymecodon and of the dihyodont upper first premolar in the Urotrichus seems to be a primitive character and is significant in determining the phylegenetical positions of these species. The first premolars of the Uropsilus are unreplaced (Thomas\(^5\),\(^4\)). This seems to suggest that Uropsilus may be a specialized divergent species (Van Valen,\(^17\) Hutchison\(^10\)), rather than the Uropsilus being the primitive species from which the Urotrichus, Dymecodon and other fossorial Talpids should be derived (Thomas\(^5\)) and

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\(^3\) See footnote \(\#\), page 91.
Campbell\(^9\)). On the other hand, the *Urotichus* possesses the hypertrophied first and second incisors and the well-developed fourth premolar in the upper jaw. In this respect, this species is considered to be the most specialized among the Talpidae. The hypertrophied upper and lower incisors of the *Urotichus* are highly adaptive to capturing the prey animals (Imaizumi\(^13\)). Therefore, the *Urotichus*, as far as the dentition is concerned, has at the same time both the primitive and specialized characters.

Although in the *Urotichus* the supernumerary tooth as a relic of the lower first premolar is considered to be a milk tooth without its successor, this does not necessarily mean that the lost first premolar was monohyodont because the loss of the first premolar seems to have been caused by the deprivation of space by the enlargement of the second premolar (especially its permanent tooth), and it is also known in other examples that in such a situation only the milk tooth appears as a supernumerary tooth (Conaway and Landry\(^13\)).

Ziegler\(^8\) suggested that the *Scalopus* and *Neurotichus* might be the only living Talpidae that might have lost the first premolars and that the living New World Talpidae and the Old World Urotichini might diverge phylogenetically from each other. On the contrary, Wilson,\(^6\) comparing the dentition of the lower jaw of the fossil Urotichini of Miocene and *Mydecodon* with those of *Dymecodon* and *Urotichus*, suggested that the dentition of the lower jaw in the *Dymecodon* might not be 2.1.3.3., as generally accepted, but 1.1.4.3 and that the New World shrew-moles and the Old World shrew-mole might be phylogenetically closely related. Similar suggestions were given also by Hutchinson\(^10\) who had compared the general skeletal mor-

**References**


18) Imaizumi, Y.: Hunting methods in relation to hunting situations in the Japanese shrew-mole, Urotrichus talpoides (in prep.).