CONTRIBUTION TO THE SYSTEMATICS OF *BAETIS MUTICUS* (L.) AND ALLIED SPECIES FROM SOUTH WESTERN PALEARCTIC REGION (EPHEMEROPTERA; BAETIDAE).

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ABSTRACT

Species of the *Baetis muticus* group from Western Europe and North Africa were investigated. The characters used to distinguish the present known species are discussed. Other characters are introduced and illustrated with optical and scanning electron microscope photographs.

The following synonymy is proposed:
Baetis muticus intermedius Alba, 1983 (nec Dodds, 1923) = *Baetis muticus* (L., 1758).

Two recently described species, *B. albinatii* Sartori and Thomas 1989 from Corsica, and *B. oukaimeden* Thomas and Sartori 1991 from the High Atlas of Morocco, are also presented and compared to their closest relative, *B. navasi* Müller-Liebenau 1974.

INTRODUCTION

Species of the *Baetis muticus* group are easily recognizable both at the nymphal and imaginal stages. The nymphs are characterized by their laterally compressed thorax, the prostheca on the right mandible reduced to two thin bristles, as well as the presence of postero-internal extensions on the paraprocts (Müller-Liebenau 1969, 1974).

Three taxa have been described from Europe: *Baetis muticus* (Linnaeus, 1758), widespread in Europe, *B. muticus intermedius* Alba-Tercedor, 1983 from Sierra Nevada and Pyrenees (Spain), and *B. navasi* Müller-Liebenau, 1974 from Serra da Estrela (Portugal). Differences between *B. m. muticus* and *B. m. intermedius* are mostly based on the ornamentation of the paraproct extension. Nymphs of *B. navasi* are mainly characterized by the lack of the first pair of abdominal gills (6 pairs) whereas the two other taxa have 7 pairs. In this study, we compare *B. navasi* with two recently described species: *B.*

albinatii Sartori & Thomas, 1989 from Corsica, and *B. oukaimeden* Thomas & Sartori, 1991 from the High Atlas of Morocco.

MATERIAL EXAMINED

B. m. muticus:

NORWAY: Finmark, Suohpatjokka, Kautekeino; 28.VI.1972; Oppland, Imsa, Ringebu, 1.VI.1981; Oslo, Holmenbekken, 6.VII.1977 (J. Brittain leg.)
ENGLAND: Westmoreland, Dale Park Beck, 17.V.1983 (T.T. Macan leg.)
AUSTRIA: Voralberg, Gurtis, 1100 m, 8.VIII.1982 (E. Gadea leg.)
SWITZERLAND: Vaud, Orbe, Vallorbe, 18.VII.1983; Menthue, Donneloye, 7.VI.1978; Torneresse, les Moulins, 17.VII.1984; Talent, Montheron, 26.VII.1985; Fribourg, l'Albeuve, 1000 m, 1.VIII.1984; Tessin, Cassarate, Roveredo, 17.V.1985 (J. Aubert & M.Sartori leg.)
FRANCE: Pyrénées-Atlantiques, Vallée d'Ossau, ruisseau de Serres, 26.VII.1984 et déversoir de Ayous, 1870 m, 2.VIII.1984 (G. Vinçon leg.); Massif Central, ruisseau des Cros, 1320 m, 30.VI.1982 (A.Thomas leg.); Var, Gapeau, Montvieux, 21.III.1982 (E. Gadea leg.); Isère, le Charmeyran, La Tronche, 12.IV.1955 (Ch. Degrange leg.)
SPAIN: Picos de Europa, aff. rio Esla, 1070 m, 11.VI.1985; rio Covadonga, La Riera, 12.VI.1985 (M. Sartori leg); Sierra de la Demanda, aff. rio Arlanzón, 13.VI.1959; Sierra de Montseny, San Celoni, 22.IV.1954; Santa Fé, 21.IV.1954; Sierra de Camero, Poveda de Soria, 14.VI.1959; Sierra de Guadarrama, rio de la Venta, Cercedilla, 10.VII.1953; rio Gudillos, San Rafael, 13.V.1954; Sierra de Albarracin, Nudo de Albarracin, 23.V.1959; rio Griegos, Bucar, 23.V.1959 (J.Aubert leg.)

B. m. intermedius:

SPAIN: Sierra Nevada, rio Mecina, Bombaron, 18.VI.1952; rio Genil, Güejar, 4.VI.1953; rio de Laroles, Laroles, 17.VI.1953; rio Juviles, Juviles, 20.VI.1953; rio Trevélez, 1600 m, 21.VI.1953 (J.Aubert leg.)

B. navasi:

PORTUGAL: Serra de Estrela, col de San Lorenzo, 7.VI.1959; torrent de Valezim, 19.IV.1960; Cabeça da Velho, 17.IV.1960 (J.Aubert leg.)

B. albinatii:

CORSICA: Vecchio, col de Vizzavona, 900-1000 m, 5.VIII.1985, 21.V.1988; Gravona, cascade du Voile de la Mariée, 5.VII.1985; aff. Taravo, Zicavo, 22.V.1988 (M. Sartori leg.)

B. oukaimeden:

MOROCCO: High Atlas, Ait, Mizan (Reghaya), 3200 and 2300 m, 23.V.1985, 26.V.1989 (A. Bouzidi leg.); Oukaimeden, 2600-2500 m, 21.IV.1982, 11.V.1984, 14.VI.1986, 15.VI.1989 (S. Assef, A. Bouzidi, J. Guidicelli & A. Thomas leg.); Tifergine, 2700-2500 m, 13.VI.1986 (H. Ouahsine & A. Thomas leg.)

METHODS

This study focused on the superficial structures of the cuticle. Observations were made with the help of an optical microscope with differential interference contrast, and a scanning electron microscope (SEM). Optical micrographs were obtained from microscopic preparations mounted in Canada balsam and observed in a Leitz Dialux 22 microscope at the University of Toulouse. SEM photographs have been realized at the Electronic Microscopy Centre of the University of Lausanne. Material was dried by the critical-point method using liquid CO_2, then gold-coated and observed at 25 mV in a JEOL JSM-35 microscope.

We were then able to estimate the range of variations in features used, some of which were not reliable. Moreover, new characters are pointed out, such as the microstructure of the gills and femora, the surface of terga or of the antennal pedicel and the ornamentation of the legs.

RESULTS AND DISCUSSION

A.- Species with 7 pairs of gills:

As previously mentioned, two taxa are known from the investigated area: *B. muticus* and *B. muticus intermedius*. Two other taxa have been described by Navás (1924, 1933), but are not considered valid:

-*B. pumilus* var. *dissimilis* Navás, 1924 from Spain. According to Müller-Liebenau (1969) and Alba-Tercedor (1984), this taxon is probably a junior synonym of *B. muticus* ;

-*B. furcatus* Navás, 1933 from northern Italy, according to Alba-Tercedor (1984), is also a junior synonym of *B. muticus*. This assertion is confirmed by the study of our material from the southern part of the Alps.

The characters used by Alba-Tercedor (1983) to separate *B. m. intermedius* from the nominate subspecies are:

- the presence of spines on the surface of the postero-internal extension of the paraprocts;
- the elongated rather than rounded anterior muscular attachments on the abdomen.

Based on our material, these two features vary considerably and do not seem to be reliable:

- the absence of spines on the surface of the extension of the paraprocts (characteristic of the typical form of *B. m. muticus*, according to Müller-Liebenau (1969,1974)) is rather rare, within the known distribution area of *B. m. muticus*, where some spines are generally present (plate 1: m); on the other hand, paraprocts of *B. m. intermedius* can bear a small number of spines (plate 1: i, and also Alba-Tercedor (1983), fig. 4 f. for instance).
- the anterior muscular attachments appear to be more or less rounded when the surface of the terga is almost smooth, or at least with very few ridges. On the contrary, when these ridges are well marked, the anterior muscular attachments are visible along a greater length (plate 2: m,i).

We consider these differences as intraspecific and probably related to the maturity of the larval instar and to the cuticular thickness. Moreover, we have found no other features, such as ornamentation of the pedicel (plate 3: m), terga (plate 4: m) or legs (table 1), allowding us to separate the larval populations of Sierra Nevada from other regions in Europe.

B.- Species with 6 pairs of gills

Until recently, only one species was known: *Baetis navasi* Müller-Liebenau 1974, from Serra da Estrela (Portugal). After examination of the holotype (nymph) deposited in the Museum of Natural History in Geneva, as well as material coming from the "terra typica", we were able to add some complements to the larval morphology of *B. navasi* (Sartori & Thomas, 1989). This research obliged us to review part of our previous determinations of specimens of "*B. navasi*" from West Mediterranean countries, and to describe two new species: *B. albinatii* (Corsica) and *B. oukaimeden* (High Atlas, Morocco) (Sartori & Thomas, 1989; Thomas *et al.*, 1991).

We present now the main distinctive features of these three species.

a) Cuticular microstructure

The chitinous surface of the integument may look smooth or more or less clearly reticulated. This can be mainly observed on: the antennal pedicel, the femora and the abdominal terga. The surface looks smooth in *B. navasi* (plate 2, 3: n), slightly reticulated in *B. albinatii* (plate 2, 3: a) and constitutes a close polygonal reticulum in *B. oukaimeden* (plate 2, 3: o)

b) Superficial angular impressions

The chitinous surface of the integument bears angular superficial impressions, which are most easily discernible on the antennal pedicel, the femora and the gills. These impressions are rather close-set in *B. navasi* (plate 3: n), less numerous and at wide intervals in *B. albinatii* (plate 3: a) and *B. oukaimeden* and even completely missing on the pedicel of the last one (plate 3: o).

c) Marginal spines

The marginal spines of the tergal hind-margin are close together, sharper and narrower in *B. albinatii* (plate 4: a) than in the two others (plate 4: n, o). In the same way, the hind spines of the paraprocts are the more pointed in *B. albinatii* (plate 1: a).

d) Legs bristles

The number of stout bristles on the external margin of femora and tibiae, especially in the forelegs is an excellent feature to distinguish the three species. Table 1 lists our data and the significance of these values (Student's t test). The three species can be separated with the number of bristles of the femora, whereas on the tibiae, *B. navasi* is easily recognizable from the two others.

CONCLUSIONS

Based on our material, it has been possible to point out the reliability of some features. The dividing of nearly allied species can be easier made using microscopic techniques for observing the microstructures of the cuticle.

Our opinion is that *B. m. intermedius* is a junior synonym of *B. muticus*. As another species of the genus *Baetis* already bears the name *intermedius* (*Baetis intermedius* Dodds, 1923: terra typica Colorado, USA), *B. m. intermedius* Alba, 1983 has to be considered as a junior homonym of *B. intermedius* Dodds, 1923.

Therefore, the following synonymies are proposed:

Baetis muticus intermedius Alba-Tercedor, 1983 (nec Dodds, 1923) = *Baetis muticus nevadensis* nom. nov. = *Baetis muticus* (Linnaeus, 1758) syn. nov.

Contrary to *B. muticus*, widespread in all Europe, other species related to *B. navasi* have a more restricted distribution area. Recent discovery of another species (Kazanci & Thomas, 1989) from the Near East (Turkey), *B. kars*, seems to confirm this fact.

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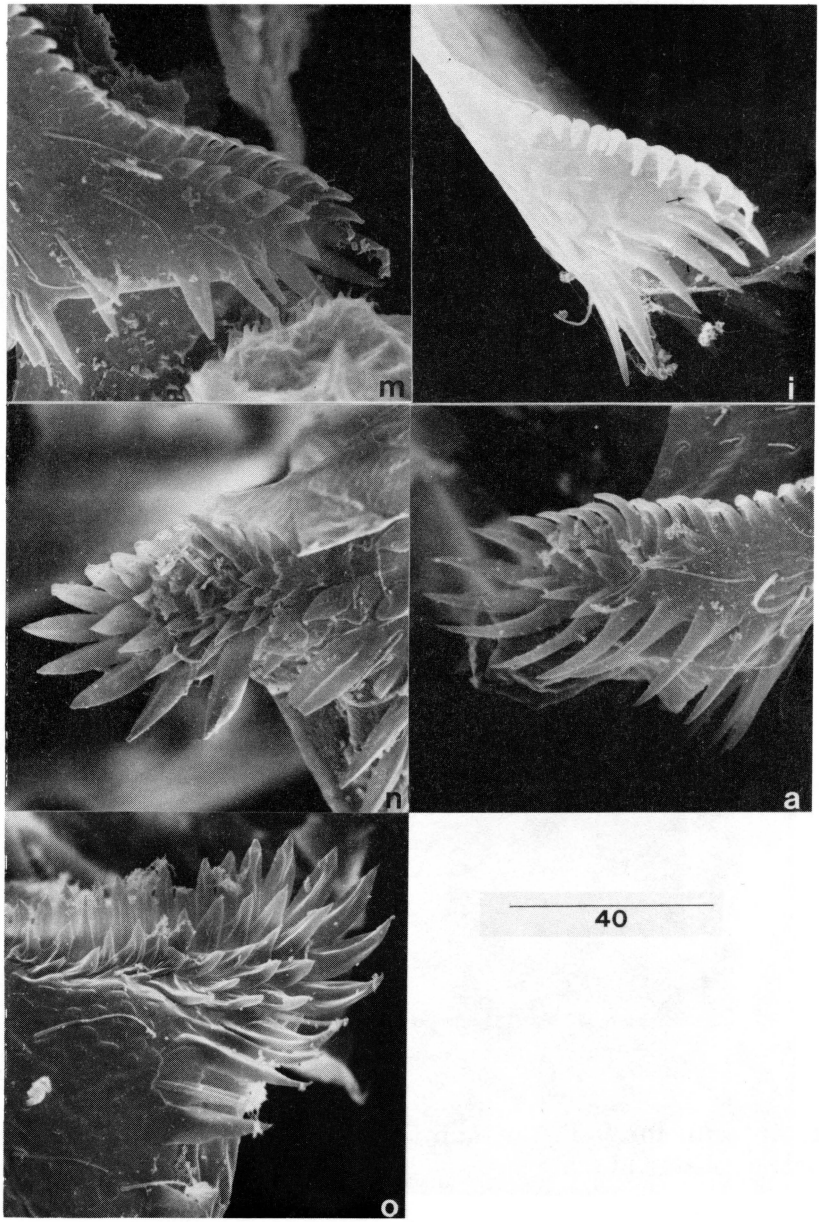

Plate 1. Postero-internal extension of the paraprocts; scale in µm. Abbreviations: m= *B. muticus*; i= *B. muticus intermedius*; n= *B. navasi*;a= *B. albinatii*; o= *B. oukaimeden*.

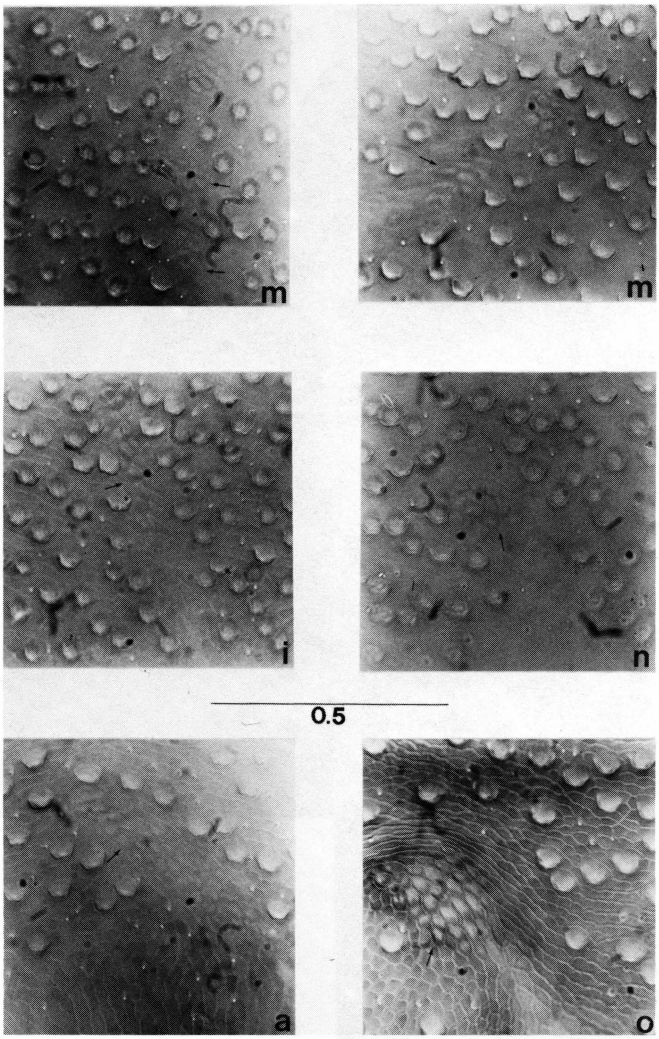

Plate 2. Anterior muscular attachments on the abdomen; scale in mm. Abbreviations as in plate 1.

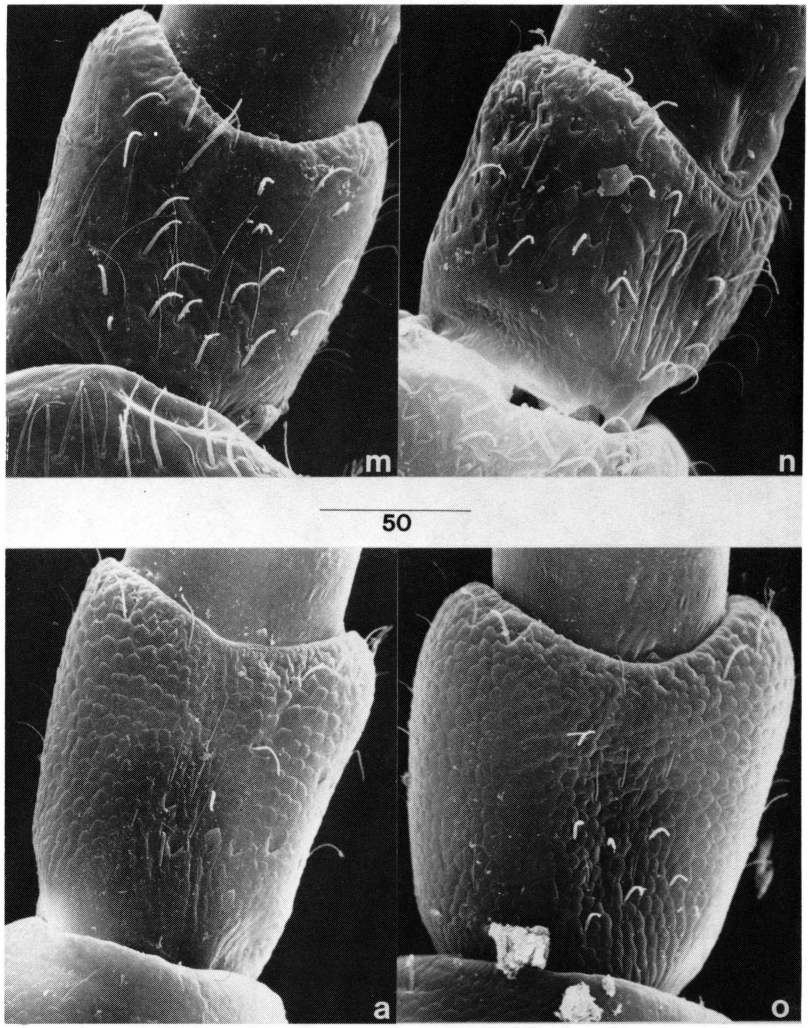

Plate 3. Antennal pedicel; scale in μm. Abbreviations as in plate 1.

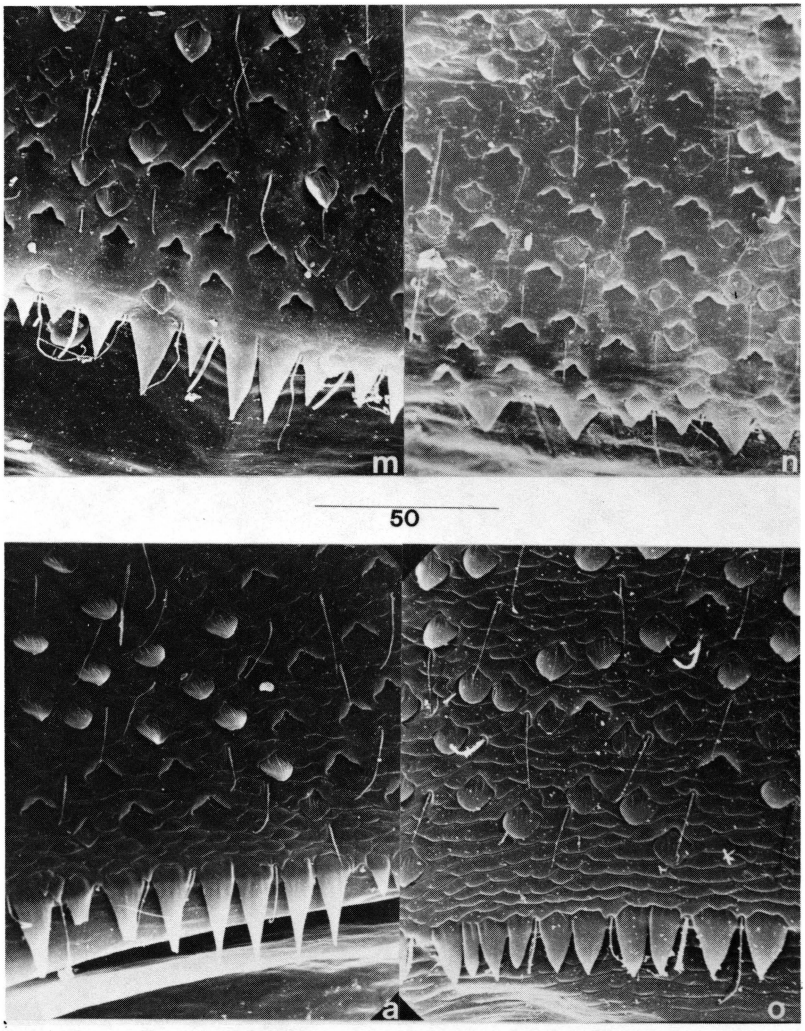

Plate 4. Hind margin of abdominal terga; scale in μm. Abbreviations as in plate 1.

Species	B. m. muticus	B. m. intermedius	B. navasi	B. albinatii	B. oukaimeden
N	14	5	4	8	10
Fore femora min.-max.	12 - 19	12 - 17	23 - 32	13 - 23	16 - 22
mean	14	15	26	16	20
Student's t test	NS		***	***	***
Fore tibiae min.-max	4 - 14	4 - 10	19 - 23	4 - 11	4 - 10
mean	8	8	21	6	8
Student's t test	NS		***	NS	***

Table 1. Differences in the bristle number on the outer margin of the fore femora and tibiae. N: number of specimens; ***=p<0.001, NS=p>0.05.