

## On development of the Aptian Ammonite zonal standard for the Mediterranean region

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**ABSTRACT.** — The paleontological characteristic of the Aptian ammonite zones of the Trans-Caspian area. There are four zones in the Lower Aptian (Bedoulian) - *tuarkyricus*, *weissi*, *deshayesi* and *furcata* ; two zones in the Middle Aptian (Gargasian) - *subnodosocostatum* and *melchioris*, three zones in the Upper Aptian (Clansayesian) - *prodromus*, *nolani* and *jacobi*. The ammonite zonation of the Trans-Caspian area is correlated with those of Caucasus, Europe and the ammonite zonal standard of Mediterranean area. The species-index of the lower zone of the Middle Aptian *Colombiceras tobleri* is proposed to change to *Epicheloniceras subnodosocostatum*.

**KEY WORDS.** — Trans-Caspian area, Aptian, ammonites, zones.

## Extension de la zonation standard d'ammonites de l'Aptien dans la province méditerranéenne

**RÉSUMÉ.** — Dans la région transcaspienne, les zones d'ammonites de l'Aptien sont caractérisées paléontologiquement. Il y a quatre zones dans l'Aptien inférieur (Bédoulien) - zones à *tuarkyricus*, *weissi*, *deshayesi* et *furcata*, deux zones dans l'Aptien moyen (Gargasien) - zones à *subnodosocostatum* et *melchioris*, et trois zones dans l'Aptien supérieur (Clansayésien) - zones à *prodromus*, *nolani* et *jacobi*. La zonation d'ammonites de la région transcaspienne est corrélée d'une part avec celles du Caucase de l'Europe et d'autre part avec la zonation standard d'ammonites de la province méditerranéenne. Pour la zone inférieure de l'Aptien moyen il est proposé de remplacer l'espèce-index *Colombiceras tobleri* par *Epicheloniceras subnodosocostatum*.

**MOTS CLÉS.** — Région transcaspienne, Aptien, Ammonites, Zones.

The Working Group on Cephalopods, acting under IGCP Project 262 "Tethyan Cretaceous Correlation" in 1990 (Alpes de Haute-Provence, Digne) developed the draft ammonite zonal scale for the Mediterranean Region [Hoedemaeker and Bulot, 1990] and proposed it for discussion. From explanations, given for different parts of the scheme [Hoedemaeker and Bulot, 1990, p.124-126], it follows that many zones, included in the draft, need an up-to-date definition and description of the zonal ammonite assemblage ; the index species of some zones, adopted as temporary ones, require a grounded substitution ; some stratigraphic intervals

were not given any names at all ; reasons should also be provided for subdivision of certain zones into sub-zones ; parts of some zones taken as horizons (to become subzones or zones) should be additionally traced over wider areas.

Subdivision of the Berriasian, Valanginian, Hauterivian and most of the Barremian is based on zonal subdivision in their stratotypes, which is, most likely, accounted for by the fact that stratotypes of these stages have been re-studied by now. For the Albian stage, zones developed by the English paleontologists for the subboreal region are accepted ; however, these

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zones are also recognized in the Mediterranean Region. Aptian is subdivided into zones developed in Georgia [Hoedmaecker and Bulot, 1990, p. 126, Comment 17]. The reason for introduction of zones of the Georgian scale in the discussed draft standard for the Aptian was, apparently, the fact that stratotype sections of the Aptian in France have not yet been revised, despite the corresponding recommendations of the Lyon Colloquium in 1963. Subdivision of the Aptian adopted there (tabl. I), does not conform to the modern state of knowledge and subdivision of these deposits in other areas of the Mediterranean or adjacent areas. The latter include western Central Asia (or Trans-Caspian area). If we discuss the Aptian zones of the developed zonal standard, it can be seen that subdivision of its lower substage (as regards the number and names of biostratons) is given totally on the basis of the Trans-Caspian area [Resolution, Samarkand, 1977]. Zones of the Middle and Upper Aptian are typical for most regions of Europe. Only the name of the upper zone of the Middle Aptian, *Colombiceras tobleri*, is taken from the modern Georgian chart, but it is not satisfactory (see below).

To improve the proposed draft it is necessary to describe zones (type sections, boundaries, characteristic of ammonite associations and their description) and give their correlation in areas of the Tethys Realm and beyond its limits. The Trans-Caspian region is referred to the most remote eastern margin of the Mediterranean, where the Aptian ammonite associations comprise both Mediterranean and subboreal species. These specific features to a certain extent affected subdivision of the Aptian deposits, which distinguishes the chart of the Trans-Caspian area from those of typical Mediterranean areas. However, the same circumstance makes the Trans-Caspian area a key region, through which correlation of charts for different paleozoogeographic provinces (or areas) is accomplished (tabl. I). Index species and ammonite associations of Aptian zones in the discussed Mediterranean scale shows certain features in common for areas in different provinces.

Aptian deposits in the Trans-Caspian area are characterized by excellent exposures, stratigraphic completeness and abundance of diverse fossil groups. The Aptian zones of this large region are characterized by ammonite assemblages, representing evolution stages of three leading families *Deshayesitidae*, *Parahoplitidae* and *Douvilleiceratidae*, i.e., the same families, whose genera and species were also widespread in coeval basins of Europe. At the same time, the developed stratigraphic scheme is composed of biostratons, representing specific geological bodies, whose boundaries are drawn on the basis of a theoretical assumption of the succession of species assemblages as a result of the evolutionary process and empirical data on relationship in the sections of particular teil-zones of species zonal assemblages and additional correlated levels determined by this

relationship : marker horizons, lithological character of strata, pattern of facies variability on area. The developed zonal scheme for the Aptian of the Trans-Caspian area is the most complete and detailed one for areas of Eastern and Western Europe (except England), included in the Tethys paleozoogeographic area, and can serve as a basis for the Mediterranean zonal standard.

Besides, in the Aptian part of the draft Mediterranean scale, not only subdivision into zones, based on materials from the Trans-Caspian sections, but also determination of the Barremian/Aptian boundary stratotype can be recommended. Ammonites of the genus *Turkmeniceras*, by now recorded only in this region, display an evolutionary transition in time from the family *Heteroceratidae*, which existed in Barremian time, to the Aptian *Deshayesitidae* [Bogdanova T.N., 1978].

Given below is a characteristic of the Aptian zones, earlier repeatedly published for different parts of the Trans-Caspian area [Bogdanova, 1983 *et al.*].

## 1. – LOWER APTIAN

Lower Aptian deposits in the Trans-Caspian area rest conformably on the Upper Barremian and are represented by rocks, similar to Barremian ones. The boundary between stages is drawn on the basis of paleontological evidence. The authors of the paper are consistently adhering to the viewpoint that the Barremian/Aptian boundary the Trans-Caspian area should be drawn at the base of the local Tuarkyricus Zone (*Deshayesites tuarkyricus*) [Luppov *et al.*, 1987]. We place the underlying Turkmenicum Zone (*Turkmeniceras turkmenicum*) in the upper part of the Barremian, correlating it with Beds with *Hemihoplites* (*Matheronites*) *ridzewski* in Northern Caucasus [Bogdanova, 1971]<sup>1</sup>.

### 1.1. Tuarkyricus Zone (*Deshayesites tuarkyricus*)

Distinguished by Bogdanova [1971, 1983], its stratotype occurs on the northern slope of the Greater Balkhan Ridge, 1-1,5 km west of Utuludzha wells. The zone is traced over the entire Trans-Caspian area. Ammonite assemblage of the zone is represented by species : *Deshayesites tuarkyricus* BOGDANOVA, *D. oglanlensis* BOGDANOVA, *D. consobrinus* D'ORBIGNY, *D. euglyphus* CASEY, *D. weissiformis* BOGDANOVA, *D. antiquus* BOGDANOVA, *Pseudohaploceras ramosum*

<sup>1</sup> It is proposed to introduce the second index *Hemihoplites* (*Matheronites*) *ridzewskii* for the unit, placed as *T. turkmenicum* horizon in the preliminary zonal chart of the Mediterranean region, as it was already done by Kakabadzé [1983]. The areal extent of this species is greater than that of species *T. turkmenicum*.

BOGDANOVA. Species *D. tuarkyricus* occurs over the entire Trans-Caspian area, which served as a basis for choosing this species as a zonal index. Species *D. consobrinus* and *D. euglyphus*, known from publications, are also found in higher Aptian levels; therefore, they cannot be regarded as guide forms of the considered zone. However, their presence in a zonal assemblage may indicate the Aptian age of beds, containing this assemblage, since the first of the species is often recorded in the Lower Aptian of Southeastern France, South England, Volga area, Caucasus, and other regions, whereas the species *D. euglyphus* is characteristic of the Lower Aptian of South England. Of certain interest is the species *D. antiquus*, whose suture-line has three umbilical lobes, as most *Deshayesites*, i.e.  $ELU_1U_3 : U_2I$ ; however, lobe  $U_1$  is located on the umbilical margin, i.e. similar to *Turkmeniceras* (early *Deshayesitidae*?). This specific feature of the structure of suture-line in *D. antiquus* allows to consider it as one of early representatives of the genus *Deshayesites*, very similar in the evolutionary series to *Turkmeniceras*; and the deposits, where it occurs, as the oldest Aptian deposits.

The lower boundary of the zone and, therefore, the lower boundary of the Aptian is drawn on the basis of disappearance of the genera *Turkmeniceras* and *Matheronites* and appearance of the above-mentioned *Deshayesites*.

In its ammonite assemblage, the considered zone has no equivalents in the scheme of Aptian subdivision for other regions of the Tethys Realm. However, by its position in the section, it corresponds to the lower zone of Aptian in England i.e. Fissicostatus Zone (*Prodeshayesites fissicostatus*) and Tenuicostatus Zone (*Deshayesites* (P.) *tenuicostatus*) in Germany [Kemper, 1976]. *Deshayesites* species, assigned to the genus *Prodeshayesites*, from the evolutionary viewpoint are more progressive, than the first *Deshayesitidae* (genus *Turkmeniceras*), which is confirmed by subdivision of the suture part of their suture-line. The lobe-formula of the species *fissicostatus*, judging by the figure in R. Casey's paper [Casey, 1964, p. 354, fig. 125d], is  $-ELU_1U_3U_4(?) : U_2I$  (with location of  $U_3$  lobe on the lateral side); i.e. it is the same, as that of *Deshayesites*, and differs from that of *Turkmeniceras*. This circumstance makes it possible to correlate the strata, starting the Lower Aptian in England and Germany, with beds, which have a higher position in the section, than beds with early *Deshayesitidae* of the Trans-Caspian area, i.e. with Tuarkyricus Zone (*D. tuarkyricus*). Stratigraphic position of this zone, which is lower than that of Weissi Zone (*D. weissii*), confirms the justified character of this correlation. In the Caucasus region, Tuarkyricus Zone should, probably, be correlated with the lower part of the Weissi and Albrechtiaustriae Zone. The difference between the compared intervals is the absence of *Cheloniceratidae* representatives in the Trans-Caspian area.

### 1.2. Weissi Zone (*Deshayesites weissii*)

Its name is taken from A. Koenen's [Koenen, 1907, p. 9] and W. Kilian's [Kilian, 1910, table to p. 287] charts. Range of the modern Trans-Caspian Weissi Zone is, most likely, equal to that of the German Weissi - Albrechtiaustriae Zone, but it is less than the range of the French zone. In the Trans-Caspian area, the Weissi Zone occurs ubiquitously; it is not subdivided into subzones. Ammonite assemblage of this zone is more diverse as compared to that of the Tuarkyricus Zone. In addition to *Deshayesites*, ammonites are represented by genera: *Phyllopachyceras* (*baborense* COQUAND), *Protetragonites* (*karakaschi* DRUZCIC, *inflatum* BOGDANOVA), *Ancyloceras* (*rochyi* CASEY), *Pseudohaploceras* (*matheroni* D'ORBIGNY, *ramosum* BOGDANOVA), *Pseudosaynella* (*bicurvata* MICHELIN, *fimbriata* IMLAY), *Chelonicerases* (*seminodosum* SINZOW, *cornuelianum* D'ORBIGNY). Defined among *Deshayesites* are: *D. weissii* NEUMAYR & UHLIG, *D. planus* CASEY, *D. dechyi* PAPP, *D. normani* CASEY, *D. callidiscus* CASEY, *D. pygmaeus* CASEY, *D. topleyi* SPATH, *D. kiliani* SPATH, *D. latilobatus* SINZOW, *D. consobrinoides* SINZOW, *D. similis* BOGDANOVA. In the upper part of the zone, *D. kudrjavzevi* I. MICHAILOVA, *D. consobrinoides* SINZOW, *D. dechyi* PAPP, *D. levigatus* BOGDANOVA and *D. deshayesi* LEYMERIE appear. The range of the Zone is established from stratigraphic range of two species: *D. weissii* and *D. planus*. The latter can be regarded as a controlling zonal species, since its vertical range is the same, as that of the species *D. weissii*. *Weissii* occurs only in Tuarkyr, Kubadag and Greater Balkhan, whereas *planus* is also widespread in Kopetdag. Generally, Weissi Zone in the Trans-Caspian area can be correlated with Forbesi Zone of the English chart or Weissi Zone in Germany. The Lower horizons of the Weissi Zone in the Trans-Caspian area, where *D. dechyi* is not yet recorded, can, possibly, correspond to the upper part of Weissi and Albrechtiaustriae Zone (*D. weissii* and *P. albrechtiaustriae*) of Northern Caucasus. However, such a correlation is arbitrary, since it is impossible to give a reliable parallelization of the boundary Barremian/Aptian beds in the considered regions.

### 1.3. Deshayesi Zone (*Deshayesites deshayesi*)

The name of the zone is taken from W. Kilian's chart [Kilian, 1910, table to p. 283].

The ammonite assemblage is much poorer than that of the Weissi Zone. This is possibly due to an extensive regional erosion of the deposits of this straton in the Trans-Caspian area. Its sections, characterized by fauna, are traceable only in western parts of the Trans-Caspian area (Tuarkyr, Greater Balkhan). The following forms are found here: *Phyllopachyceras baborense* COQUAND, *D. dechyi* PAPP, *D. levigatus* BOGDANOVA, *D. kudrjavzevi* I. MICHAILOVA, *D.*

*consobrinoides* SINZOW, *D. deshayesi* LEYMERIE, *D. babaschensis* BOGDANOVA, *Toxoceratoides royerianus* D'ORBIGNY, *Chelonicerases cornuelianum* D'ORBIGNY. The vertical range of several species is not restricted only by this zone ; some of the forms "pass" from Weissi Zone, among them *D. deshayesi*. Therefore, we are drawing the lower boundary of the Deshayesi Zone on the basis of disappearance of *D. weissii*, *D. planus*, *D. topleyi* and other *Deshayesites*, occurring lower.

Most ammonites of the Deshayesi Zone in the Trans-Caspian area allow placing it under the upper *Deshayesites* Beds of the Lower Aptian of Europe. However, correlation with zones of the same name in other regions is connected with great difficulties, since different workers propose markedly different interpretations of the range of Zones. In a layer-by-layer description of stratotype of the Bedoulian (lower) substage of the Aptian Southeastern France (Colloque sur le Crétacé inférieur, Lyon, septembre 1963 ; 1965) this species was indicated only in its middle part, whereas in Resolutions of the Lyon Colloquium of 1963, Deshayesi Zone corresponds to the entire Bedoulian (Colloque sur le Crétacé inférieur, Lyon, septembre 1963 ; 1965). In the stratigraphic chart of the Lower Aptian in England [Casey, 1961], which comprises four zones, it is known from the upper *Deshayesites* Beds. In the Russian Platform, this form is indicated as being characteristic of the lower one of two ammonite horizons, distinguished in the Lower Aptian of the Volga area. In Northern Caucasus, *D. deshayesi* occurs in the upper *Deshayesites* beds, distinguished as Deshayesi and Dechyi Zone [Mordvilko, 1960], together with *D. kurdjatzevi* and *D. consobrinoides*.

One of the causes of discrepancy between the ranges of stratigraphic units of the same name is also different interpretation of the range of species *D. deshayesi*, which often does not take account its evolution in time. The species *D. deshayesi* is long-lived, which give various mutations in time. R. Casey noted that in the English representatives of *D. deshayesi* early whorls are characterized by the most long-term growth stage and a smooth venter. Proceeding from the assumption, that in the evolution process of the genus *Deshayesites*, costae start to intersect the venter at increasingly later whorls, R. Casey regards this species as an ancestral species of the genus *Dufrenoya* [Casey, 1964]. In Trans-Caspian representatives of this species, a break in costae on the venter of the shell is most often not recorded ; at any rate, this concerns those specimens, which were found in beds together with *D. weissii*. It is quite likely, that they yield the most ancient representatives of the species. In Deshayesi Zone in England, possibly, a younger mutation of the species or a subspecies occurs, which gave rise to the genus *Dufrenoya*. Correlation of the lower boundaries of Deshayesi Zones in Trans-Caspian area and England is controlled by disappearance of most species of the underlying zones, which

are clearly correlated with each other. When correlating upper *Deshayesites* beds in England and Trans-Caspian area account, should be taken of the following circumstances : 1) absence in the Trans-Caspian area of such species as *D. grandis* SPATH, *D. vectensis* SPATH, and other ammonites, characteristic of the upper Deshayesi Subzone in the English sections ; 2) absence, even in the uppermost beds, among the Trans-Caspian representatives of the species *D. deshayesi*, of specimens with distinct features of late mutations of this species ; 3) erosion of the upper beds of Deshayesi Zone in the Trans-Caspian area. This enables us to presume that, generally, the Deshayesi Zone of the Trans-Caspian area does not correspond to the entire Deshayesi Zone in England, but only to its lower Subzone, i.e. Parinodum (*Chelonicerases parinodum*).

In view of the above-mentioned specific features of the species *D. deshayesi*, its choice as a zonal index seems to be temporary. At any rate, specimens from the same locality, where Leymerie's specimen was found, should be studied, or from nearby localities. Besides, the stratigraphic level of this species in the Lower Aptian (Bedoulian) type section should be clearly defined, since data on this section, located in southern France, should be primarily taken into account, when the stratigraphic chart for the Mediterranean Region is developed.

#### 1.4. Furcata Zone (*Dufrenoya furcata*)

The straton with the above index was erected by Ch. Jacob [1907<sup>163</sup>]. Later, the zone, which has *D. furcata* as one of its index species, was present in V.P. Renngarten's chart [Renngarten, 1954<sup>163</sup>]. In West Turkmenian sections, deposits with *D. furcata* rest with erosion on the underlying deposits.

At the boundary of the Deshayesi and Furcata Zones, the ammonoid assemblage changes markedly. Representatives of the genus *Deshayesites* disappear, and the genus *Dufrenoya* becomes widespread (*furcata* SOWERBY, *subfurcata* KASANSKY, *dufrenoyi* D'ORBIGNY, *lurensis* KILIAN, *sinzovi* LUPPOV, *scalata* CASEY, *fursovae* BOGDANOVA, etc.). Another late genus of the family *Deshayesitidae*-*Burckhardtites* is less frequent (*palumbes* HAMPHREY, *gregoriensis* HAMPHREY, *imlayi* HAMPHREY), which up to now has not been recorded in Europe. In addition to the above genera *Chelonicerases* is also found in this zone (*seminodosum* SINZOW, *cornuelianum* D'ORBIGNY), *Toxoceratoides* (*royerianus* D'ORBIGNY), *Aconeceras* (*nisoides* SARASIN), *Tropaeum*, whose stratigraphic range is wider than a zone.

Furcata Zone of the Trans-Caspian area is correlated with Furcata Zone and Subfurcata Zone of Northern Caucasus and Dagestan. In South England it corresponds to Bowerbanki Zone, which yields almost the same *Dufrenoya* and *Chelonicerases* species. A

specific feature of the Trans-Caspian sections are single finds of uncoiled shells of the genus *Tropaeum*.

## 2. – MIDDLE APTIAN

The boundary between the lower and middle substages of Aptian in the Trans-Caspian area, drawn along the boundary of Furcata Zone and Subnodosocostatum Zone remains not correlated with the boundary drawn between Bedoulian and Gargasian in France, where it coincides with the base of beds, containing *Dufrenoya*. Possibly, this boundary is drawn at different stratigraphic levels, i.e. the upper part of the Trans-Caspian Furcata Zone corresponds to the lower part the Gargasian Nisus Zone in France. Boundary with the Lower Aptian deposits in the Trans-Caspian area is drawn on the basis of a distinct succession of paleontological assemblages. Middle Aptian in the time of predominance of the family *Parahoplitidae* and subfamily *Colombiceratinae*. The first *Colombiceratinae* appear already in Furcata Zone (*Gargasicerat* sp. in Tuarkyr).

### 2.1. Subnodosocostatum Zone (*Epicheloniceras subnodosocostatum*)

This zone first appeared as an independent unit (subzone) in Ch. Jacob's chart [Jacob, 1907] and had two indexes, i.e. *subnodosocostatum* and *buxtorfi*.

Zonal ammonite assemblage is extremely rich and diverse. Genus *Epicheloniceras* (which replaced *Cheloniceras* in the Early Aptian) is represented by the species *subnodosocostatum* SINZOW, *tschernyschewi* SINZOW, *buxtorfi* JACOB, *pussillum* KASANSKY, *stuckenbergy* KASANSKY; among *Parahoplitidae*, the genus *Colombicerat*, which is the second in time, is widespread (*tobleri* JACOB, *subtobleri* KASANSKY, *caucasica* LUPPOV); *Aconeceras* become more abundant: *A. nisus* D'ORBIGNY, *A. haugi* SARASIN. An interesting group are heteromorphic ammonites of the genera *Ammonitoceras* (*wassiliowskyi* RENNGARTEN, *transcaspium* SINZOW), *Australiceras* (*pawlowi* WASSILIEWSKY), *Luppovia* (*dotshanensis* BOGDANOVA, KAKABADZE and I. MICHAILOVA, *adjiderensis* BOGDANOVA, KAKABADZE and I. MICHAILOVA). In sections of western regions (Tuarkyr, Greater Balkhan, Kubadag) *Salfeldiella guettardi* RASPAIL, *Tetragonites depressus* RASPAIL, *Jauberticeras latericarinatum* ANTHULA occur.

The species *E. subnodosocostatum* is known from the lower zone of the Middle Aptian in Mangyshlak, Northern Caucasus, Dagestan, Georgia, northern Germany and Southeastern France, and some workers have chosen it as an index species. *E. tschernyschewi* and *E. buxtorfi* are often found in the considered zone in Mangyshlak, Northern Caucasus, and England. Some

heteromorphic ammonites have a narrow stratigraphic range (are confined only to this zone); among them, the species *A. wassiliowskyi* can also be regarded as a zonal species for the Trans-Caspian area.

Analysis of the species composition of ammonites assemblage in the lower part of the Middle Aptian over the extensive territory of southern Eastern and Western Europe has shown that this assemblage is extremely constant both in its species, and generic composition. This circumstance makes easier correlation of the Subnodosocostatum Zone with the lower unit of the Middle Aptian (often having the same name) in the considered area.

### 2.2. Melchioris Zone (*Parahoplites melchioris*)

The zone was first distinguished in Mangyshlak by A.D. Natsky as Beds with *P. melchioris*. Later, it was studied in detail in the Caucasus [Druschits *et al.*, 1966; Eristavi, 1960; Luppov, 1956; Mordvilko, 1960 and Renngarten, 1951] and was named after the highest abundance of the species *P. melchioris* in these deposits.

A fossil assemblage in the considered zone differs from that of the Subnodosocostatum Zone by appearance of ammonites of the genus *Parahoplites* (*schmidt* JACOB & TOBLER, *grossouvrei* JACOB, *campichei* PICTET & RENEVIER, *melchioris* ANTHULA, *sjogreni* ANTHULA, *debilicostatus* I. MICHAILOVA, *multicostatus* SINZOW, *transitans* SINZOW, *subcampichei* SINZOW, *irregularis* CASEY, *luppovi* TOVBINA). Ammonites of the new genus of *Colombiceratinae*, i.e. *Protacanthoplites* [Tovbina, 1970, 1982] also occur here; this genus is a link in the lineage *Colombicerat*-*Acanthohoplites*. It is represented by species *P. monilis* TOVBINA, *P. mirus* TOVBINA, *P. abichi* ANTHULA, *P. submirus* TOVBINA, *P. multinodosus* TOVBINA, *P. bogdanovae* TOVBINA, *P. quadratus* KASANSKY, *P. aff. bigoureti* SEUNES, *P. bigoti* SEUNES, *P. bigoti incivilis* GLASUNOVA, etc. Ammonites of this genus are predominant in the upper part of the Melchioris Zone. In Central, southern part of Western and Eastern Kopetdag, the upper part of Melchioris Zone, where representatives of the genus *Parahoplites* are not found, and *Protacanthoplites* are abundant, was distinguished by Tobvina [1982] as Monilis Subzone (*P. monilis*) (the most frequent species). The genus *Colombicerat* is represented by the same species, as in the Subnodosocostatum Zone. In this connection, attention should be paid to substitution of the index species for Tobleri Zone (*C. tobleri*) in the draft scale of the Mediterranean region [Hoedemaeker and Bulot, 1990]. Since in Trans-Caspian area and in Northern Caucasus species *C. tobleri* characterizes both zones of the Middle Aptian, it is probably not reasonable to make it the index species for one of them; the more so, as among species of other genera, particularly such a well known genus as *Parahoplites*,

the index for the upper zone of the Middle Aptian can be chosen. We propose the species *P. melchioris*, since it occurs not only in the Trans-Caspian area, but also in Northern Caucasus, Transcaucasus and Germany, where it accompanies the species *P. nutfieldiensis*, index of one of the Middle Aptian Zones in the Boreal region, which is, most likely, a full equivalent of the Melchioris Zone. In addition to the above ammonites, this zone also contains genera *Aconeceras* (*nisus* D'ORBIGNY, *haugi* SARASIN), *Sanmartinoceras* (*aptianum* SARASIN), *Euphyloceras* (*velledae* MICHELIN, *aptiense* SAYN, *anthulai* KASANSKY), *Zurcherella* (*zurcheri* JACOB), *Tetragonites* (*depressus* RASPAIL, *heterosulcatus* ANTHULA).

### 3. – UPPER APTIAN

#### 3.1. Prodrumus Zone (*Acanthohoplites prodromus*)

Distinguished by Tovbina [1968]. The section on the southern slope of the Elli-Kaya Ridge in Kopetdag is chosen as a stratotype.

Most frequent in Prodrumus Zone are ammonites of genera *Diadochoceras* and *Acanthohoplites*. Here, the *Clansayesia* subgenus *Eodouvilleiceras* of the genus *Epicheloniceras* appears. Several species of the typical Clansayesian genus *Diadochoceras*: *nodosocostatum* D'ORBIGNY, *causasicum* LUPPOV, aff. *hokodsens* I. MICHAILOVA, and local species *latiumbonatum* TOVBINA, *longispinatum* TOVBINA, *pseudomulti-spinatum* TOVBINA in the Trans-Caspian area are confined to this zone; but it is on the basis of their presence that the Prodrumus Zone is regarded as a part of Nolani Zone in most areas of Eastern and Western Europe. *Acanthohoplites* are dominated by local species: *A. prodromus prodromus* TOVBINA, *A. enodis enodis* TOVBINA, *A. raricostatus* TOVBINA, *A. balchanensis* TOVBINA; there are wellknown *A. trautscholdi* SIMONOVITCH, BACEVITCH & SOROKIN, *A. aschiltaensis* ANTHULA, or affined *A. aff. bergeroni* SEUNES, "A." aff. *bigoti* SEUNES. Among the Clansayesian *Epicheloniceras*: *E. (Eodouvilleiceras) badkhyzicum* URMANOVA, *E. (E.) clansayense* JACOB should be indicated.

Historically, beds taking up the interval between the Melchioris and Nolani Zones were distinguished in the Aptian sections of the Trans-Caspian area. In Kopetdag, they were named Aschiltaensis Zone (Subzone) (*A. aschiltaensis*) by analogy with subdivision of the Upper Aptian in Northern Caucasus [Lupov et al., 1960]. In Tuarkyr, Beds with *Acanthohoplites* ex. gr. *uhligi* and *Diadochoceras* [Bogdanova et al., 1963]. Then S.Z. Tovbina, who studied ammonites of this straton, showed that it did not correspond to the Caucasian Aschiltaensis Zone (*A. aschiltaensis*) (this zone, most likely, corresponds in the Trans-Caspian area to the upper part of Melchioris Zone and, possibly, to the lowermost part of Prodrumus

Zone), but rather to the lower part of the widespread Nolani Zone. In the zonal chart of the Mediterranean region it corresponds to *D. nodosocostatum* horizon.

#### 3.2. Nolani Zone (*Acanthohoplites nolani*)

First appeared as an independent straton in the "Standard of Cretaceous System" [Müller and Schenk, 1943], and soon afterwards Renngarten provided grounds for it, using the material from the Greater Caucasus [Renngarten, 1951]. It is traceable throughout the Trans-Caspian area.

The assemblage of Trans-Caspian *Acanthohoplites* of this zone was first described by Sinzow [1908] from sections of Mangyshlak. It is much richer and diverse than that in underlying deposits. In addition to *Acanthohoplites*, there sometimes occur *Eodouvilleiceras*, also indicated in *prodromus* Zone: *E. (E.) badkhyzicum* URMANOVA and *E. (E.)* ex. gr. *clansayense* JACOB. The zonal index species *A. nolani* is rather rare in the Trans-Caspian area. The following species are more abundant in this region: *A. migneni* SEUNES, *A. multispinatus* ANTHULA, *A. uhligi* ANTHULA, *A. trautscholdi* SIMONOVITCH, BACEVITCH & SOROKIN, *A. subangulicostatus* SINZOW, *A. subrectangulatus* SINZOW, *A. lorioli* SINZOW, *A. anthulai* KASANSKY, *A. compressus* KASANSKY, *A. elegans* GLASUNOVA, *A. subangulatus* LUPPOV. These species are known from the *nolani* Zone of Mangyshlak, Northern Caucasus, Transcaucasus, and Western Europe. Besides the widely known species, some parts of the Trans-Caspian area are characterized by local species: *A. geokderensis* TOVBINA, *A. trapezoidalis* TOVBINA and *A. asiaticus* TOVBINA. Phylloceratids and tetragonitids are represented by the same species, as in underlying deposits.

The Trans-Caspian *nolani* Zone, most likely, corresponds to the upper part of the zone of the same name, extensively traced in Europe, and in the chart for the Mediterranean region, to that interval of *nolani* Zone, which occurs above *D. nodosocostatum* horizon.

#### 3.3. Jacobi Zone (*Hypacanthoplites jacobi*)

In the Trans-Caspian area this zone was distinguished by A.D. Natsky<sup>2</sup>. Then it appeared in the chart of the Greater Caucasus [Renngarten, 1951] as Jacobi-Tscharloekensis Zone (*H. jacobi* - *H. tscharloekensis*). And later, for the same region as Jacobi Zone (*H. Jacobi*) [Eristavi, 1960]. It is not traced over the entire Trans-Caspian area. It was subject to erosion in West Turkmenian sections, in Mangyshlak and, locally, in Lesser Balkhan.

The boundary of the Jacobi Zone with the underlying deposits is drawn on the basis of

<sup>2</sup> Manuscript of A.D. Natsky 1918 has not been published and is kept at VSEGEI, St-Petersburg.

replacement of *Acanthohoplites* by species of the genus *Hypacanthoplites*. In the boundary beds of Nolani and Jacobi Zones, *Acanthohoplites* with outlined tubercles on the venter are found, which are, possibly, transitional to *Hypacanthoplites*; however, the tubercles are much less pronounced than in the latter genus. Unfortunately, these species have not yet been adequately studied. The *hypacanthoplites* assemblage comprises widely known West European species, on which basis the upper zone of the Clansayesian is correlated over an extensive territory: *H. jacobi* COLLET, *H. milletianus nodosocostatus* FRITEL, *H. sarasini* COLLET, *H. spathi* DUTERTRE, *H. hanoverensis* COLLET. The species *H. asper* GLASUNOVA, *H. kopetdagensis* GLASUNOVA and *H. tscharlokensis* GLASUNOVA were described by Glasunova from the considered deposits of Western Kopetdag. Herefrom Natsky also described the species *H. nolaniformis* GLASUNOVA. The last-mentioned species and *H. tscharlokensis* are presently known from the Jacobi Zone in the Northern Caucasus. In addition to *Hypacanthoplites*, this zone also contains single *Euphyloceras* aff. *velledae* D'ORBIGNY.

The constant species assemblage of the Jacobi Zone and its consistency over an extensive area in southern and middle Europe justify the introduction of this zone into the considered draft.

#### 4. — CONCLUSION

1) The present paper characterizes Aptian zones of the Trans-Caspian area, including those, which are comprised into the draft ammonite zonal scale for the Mediterranean region, i.e. Tuarkyricus, Weissi, Deshayesi, Furcata, Subnodosocostatum, Nolani (local Trans-Caspian Prodromus Zone corresponds in its stratigraphic range to *D. nodosocostatum* Horizon), and Jacobi. It is proposed to replace the index species for the Tobleri Zone (*C. tobleri*).

2) As mentioned above, type sections of the Aptian substages in Southeastern France up to now remain unrevised. Data on these sections should, doubtless, be taken into account, when the Aptian scale for the Mediterranean Region is developed. As is known from the earlier published papers, the type sections of the Bedoulian, Gargasian, and Clansayesian, in case of their most accurate study, cannot, unfortunately, offer good prospects as regards the number and preservation of the contained ammonite remains for solving the problem of zonal subdivision of the Aptian, and the zonal index species. In this connection, apparently, a problem can be raised of choosing parastratotypes of Aptian substages or of the stage in general. For this purpose, sections of the Trans-Caspian area and the Caucasus, which are stratigraphically complete and richly characterized by diverse faune, can be used.

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