Stratigraphical part

B. STRATIGRAPHICAL PART

Description of the sections

(Fig. 132)

The three sections, measured in the Scaglia of the Central Apennines, belong to the North Umbrian facies belt (see O. RENZ, 1936). This belt is characterized by a continuous pelagic facies, ranging from Albian to Oligocene.

Turbidites of clastic material – as characteristic for the South Umbrian facies – are practically absent within these sequences, although a few layers with laminated bedding may occur locally (e.g. Fossombrone, Furlo, Genga). The present description is restricted to the Paleocene and Lower Eocene. Two of the sections are situated immediately north of Gubbio (Prov. di Perugia), the third section is located near Fossombrone (Prov. di Pesaro ed Urbino) (see sketch map, fig. 129).

1. Section of the Gola del Bottaccione («Gubbio section»)

A few hundred meters north of the medieval town of Gubbio, in the Gola del Bottaccione, there is an outcrop along the Gubbio–Scheggia road (fig. 130) of a continuous section ranging from Upper Jurassic to Lower Oligocene. Since the thesis of O. RENZ (1936), this section represents one of the classic European localities for the study of the Upper Cretaceous and the Lower Paleogene in pelagic facies. For further references, the papers of O. RENZ (1936), BARNABA (1959), and PREMOLI SILVA & LUTERBACHER (1962) may be consulted.

The Cretaceous/Tertiary boundary is exposed about 60 m below the bridge of the old aqueduct over the road. The highest layers of Maestrichtian age (G-99–G-97B) are represented by a well bedded reddish limestone rich in *Globotruncana*, *Rugoglobigerina* and costate *Heterohelicidae* (see faunal list in PREMOLI SILVA & LUTERBACHER, 1962).

The faunal break within planktonic foraminifera marking the Cretaceous/Tertiary boundary is sudden and very impressive. It occurs between the levels G-97B and G-97C. A detailed description of this interval is given in PREMOLI SILVA & LUTERBACHER (1964).

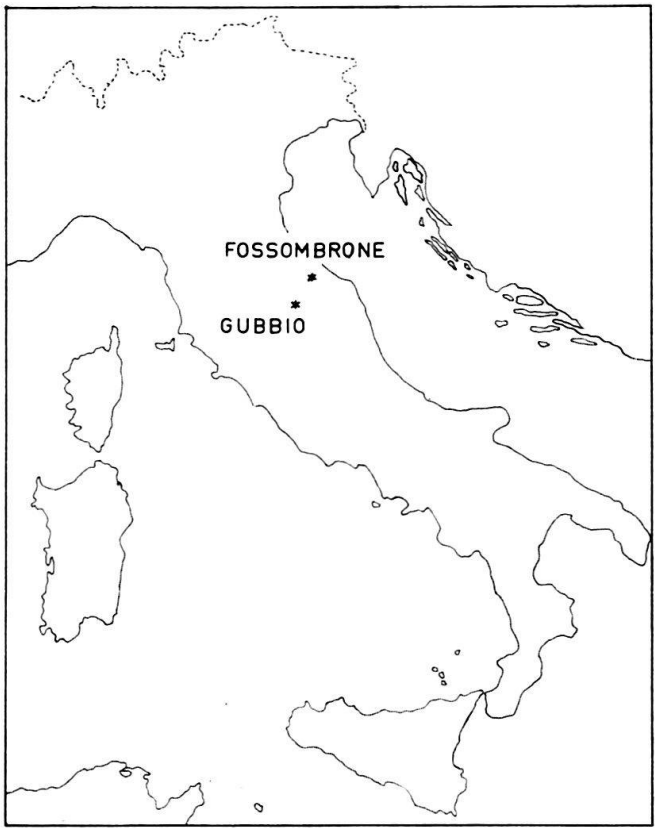


Fig. 129. Sketch-map of Italy with location of the studied sections.

G-97C–G-95. Irregularly thin-bedded reddish limestone with rare and thin (1–3 cm) marly seams. The faunas of G-97C–G-97L (lowermost 50 cm) belong to the Globigerina eugubina zone (type-locality). G-96 and G-95 contain badly preserved and poor faunas indicating the lower part of the Globorotalia pseudobulloides/Globigerina daubjergensis zone. Reworked Upper Cretaceous forms are present at level G-96 (*Rugoglobigerina*, *Globotruncana*, rare *Neoflabellina* and *Siderolites*).

G-94–G-89. Thin-bedded, reddish limestone, irregularly interbedded with argillaceous limestone and red marls. The samples G-94, G-93 and G-92 contain rich, but generally poorly preserved faunas of the Globorotalia pseudobulloides/Globigerina daubjergensis zone. G-91 to G-89 represent the lower part of the Globorotalia trinidadensis zone.

G-88–G-86. Irregularly thin-bedded, reddish, argillaceous limestone and marls, with only a few layers of compact limestone.
The rich and well preserved faunas are attributed to the Globorotalia trinidadensis zone (*Globorotalia trinidadensis*, *Globorotalia inconstans*, *Globigerina pseudobulloides*, *Globorotalia compressa*, *Globorotalia praecursoria* (beginning at level G-86), *Globigerina daubjergensis* (with secondary sutural apertures on its spiral side), *Globigerina trivialis*, *Globigerina varianta*, *Globigerina triloculinoides*). Sample G-87 contains rare reworked Upper Cretaceous forms (e.g. *Neoflabellina* ex gr. *sphenoidalis*).

G-85–G-79. Predominantly well-bedded, compact, reddish limestone, with a few layers of argillaceous limestone and red calcareous marls.

The levels G-85–G-82 are attributed to the Globorotalia uncinata zone. Faunas are rich in G-85, poor in G-84 (*Globorotalia trinidadensis*, *Globorotalia* sp. aff. *inconstans*, *Globorotalia praecursoria*, *Globorotalia schachdagica* (only in G-85, very rare), *Globorotalia perclara* (starting at G-82), *Globorotalia uncinata*, *Globorotalia ehrenbergi* (starting at G-84), *Globorotalia angulata* (starting at G-83).

The beds between G-82 and G-79 belong to the Globorotalia pusilla pusilla zone (*Globorotalia praecursoria* (only until G-81), *Globorotalia perclara*, *Globorotalia angulata*, *Globorotalia conicotruncata* (starting at G-80), *Globorotalia tadjikistanensis* (starting at G-79), *Globorotalia simulatilis*, *Globorotalia pusilla pusilla*, *Globorotalia ehrenbergi*, *Globorotalia chapmani* (only in G-79).

In G-82 and G-81, rare reworked *Globotruncana* are observed.

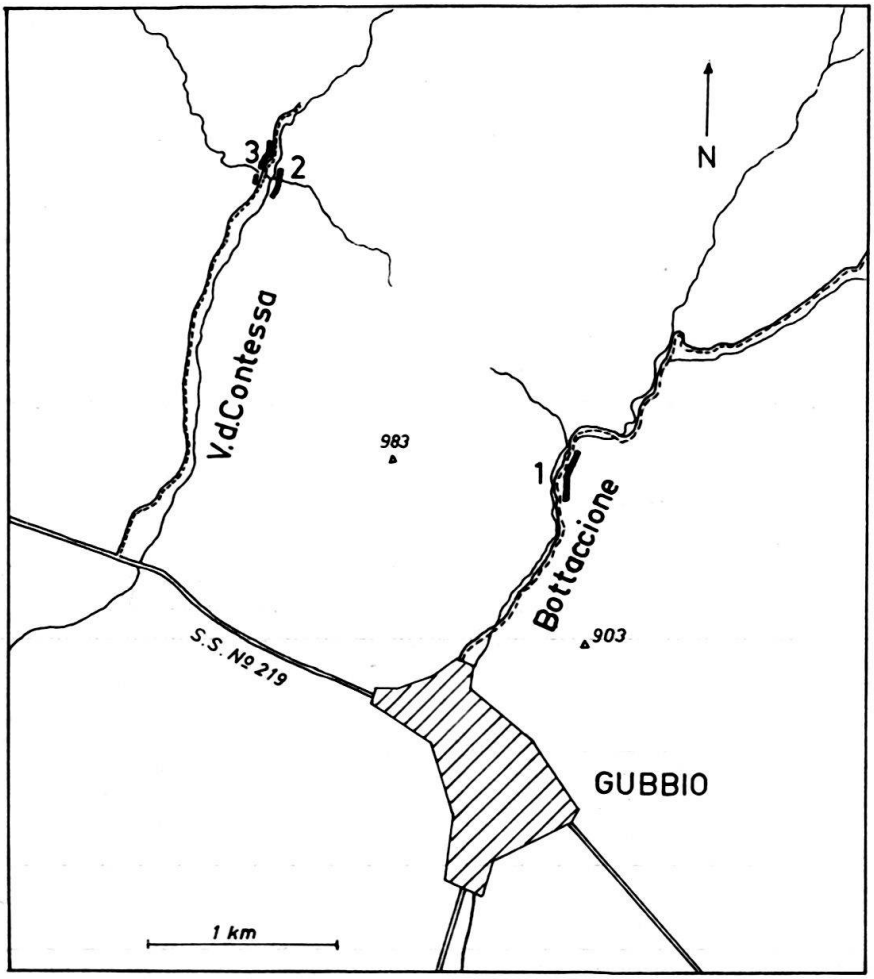


Fig. 130. Sketch-map of the region of Gubbio with location of the studied sections.

G-78–G-75a. Generally well-bedded reddish limestone with fewer argillaceous layers.

Rich, generally incrusted faunas could be isolated from the marly seams at G-78 and G-77. They belong to the Globorotalia pseudomenardii zone (*Globorotalia angulata* (not in G-77), *Globorotalia conicotruncata*, *Globorotalia simulatilis*, *Globorotalia* sp. aff. *kolchidica* (rare), *Globorotalia acutispira* (G-78–G-76), *Globorotalia acuta*, *Globorotalia chapmani*, *Globorotalia pseudomenardii*, *Globorotalia pusilla pusilla*, *Globorotalia pusilla laevigata*).

The samples G-76a, G-76 and G-75a could be investigated in thin sections only. The presence of flattened, keeled «*Planorotalia*» indicates the Globorotalia pseudomenardii zone. At level G-76a, the first forms appear which might be compared to *Globorotalia velascoensis*.

G-75–G-70a. Irregularly bedded, reddish, argillaceous limestone and marls with sporadic layers of compact limestone. The faunas of G-75–G-73a belong to the Globorotalia velascoensis zone. The absence of large multichambered *Globorotalia velascoensis*, abundant in G-74, causes a pronounced change between the faunas of G-74 and G-73. Samples G-73–G-70a contain: *Globorotalia marginodentata*, *Globorotalia subbotinae*, rare *Globorotalia acuta* and *Globorotalia pasionensis* (only in G-71a and G-71).

The sample G-72 consists almost entirely of reworked Upper Cretaceous forms.

The samples G-73–G-70a are attributed to the Globorotalia aequa zone.

G-70–G-64. Generally well-bedded, compact reddish limestone with a few marly seams.

The poor faunas contained in the samples G-70–G-64 indicate the Globorotalia formosa formosa/Globorotalia subbotinae zone (*Globorotalia aequa*, *Globorotalia marginodentata*, *Globorotalia subbotinae*, *Globorotalia formosa formosa*, *Globorotalia formosa gracilis*).

G-63–G-60. Irregular alternation of reddish, compact limestone, argillaceous limestone and thin layers of red marls. At G-60, 20–30 cm of marls are intercalated. (Between G-60 and G-59, the ancient aqueduct, which has now – summer 1964 – been barbarically destroyed, passes over the road.)

The fauna is still characteristic for the Globorotalia formosa formosa/Globorotalia subbotinae zone.

G-59–G-53. Reddish, compact limestone, interbedded with argillaceous limestone and few thin layers of marls. In this part of the section, the stratification is slightly disturbed, probably caused by surface sliding.

The faunas are characterized by the presence of *Globorotalia formosa formosa*, *Globorotalia formosa gracilis*, *Globorotalia quetra*, *Globorotalia bullbrooki*, *Globorotalia marginodentata* (only G-59, G-58) and *Globorotalia aragonensis* (starting at G-55). They are intermediate between the Globorotalia formosa formosa/Globorotalia subbotinae zone and the Globorotalia aragonensis zone.

G-53–G-52. Alternation of compact limestone, argillaceous limestone and marls. First occurrence of red and greenish chert nodules («selci»).

G-51–G-31. Well-bedded compact limestone with irregularly scattered layers of chert nodules and lenses (largest up to 50 cm long and 5 cm thick). The limestone is predominantly reddish at the base and predominantly greenish at the top. Only a few thin layers of marls (G-49, 15–20 cm thick) and marly seams are present, but become more frequent between G-39 and G-36.

The faunas between G-51 and G-39 belong to the Globorotalia aragonensis zone (*Globorotalia formosa formosa* (only until G-49), *Globorotalia bullbrooki*, *Globorotalia broedermanni* (starting at G-46), *Globorotalia aragonensis*, *Globorotalia pentacamerata* (flooding in G-49)).

The faunas between G-39 and G-31 are difficult to correlate with the zonation established by BOLLI in Trinidad. The zonal marker *Globorotalia palmerae* of the uppermost zone of the Lower Eocene has not yet been found. The faunas in this part of the section correlate best with the Globorotalia «crassaformis» zone of Soviet authors.

G-37 has yielded a reworked fauna from the Globorotalia aequa zone.

G-31–G-29. Compact, greenish, partly reddish limestone without chert nodules.

The thin marly layer at G-30 contains a reworked fauna, probably corresponding to the faunas in samples G-56–G-50.

G-29–G-20. Regular alternation of compact to argillaceous, greenish and reddish limestone and marls. The samples from the reddish marls at G-28, G-25 and G-21 display intensive reworking.

By the presence of «*Globigerinoides higginsi*, *Globigerina senni*, *Globorotalia bullbrooki* and predominantly sinistrally coiled *Globorotalia aragonensis* (coiling random at G-28), this interval may correspond to the upper part of the Globorotalia palmerae zone or to the Hantkenina aragonensis zone (BOLLI, 1957).

In this part of the section, only keeled *Globorotalia* have been studied. Knowledge of the whole fauna would probably allow a better correlation with the current zonations. The appearance of *Hantkenina liebusi* and *Hantkenina dumblei* in sample G-20 marks definitively the beginning of the Middle Eocene.

2. Valle della Contessa

2–3 km northeast of Gubbio, in the Valle della Contessa, a recently constructed road along the western slope of the valley has uncovered a section parallel to that of the Gola del Bottaccione (see BARNABA, 1959, sketch-map fig. 130).

Because of a gap within the main section, caused by the bridge at Pt. 585 (no. 3 on the sketch-map, samples V-1–V-119), a complementary section has been measured on the eastern slope of the valley, along the small path leading to Osteria Valderchia (no. 2 on sketch-map fig. 130, samples K-1–K-42).

The Cretaceous/Tertiary boundary (K-1) is situated about 70 m south of the small bridge at Pt. 558, north of Casa Bruciata. It is similar to that in the section of the Gola del Bottaccione (see PREMOLI SILVA & LUTERBACHER, 1964).

K-1–K-2. Thin-bedded red limestone and argillaceous limestone. At K-2, a thin layer (3 cm) of dark red marls.
The faunas contained in the basal 0.75 cm of the Tertiary correspond to the Globigerina eugubina zone.
The sample K-2 contains a fauna of the lowermost part of the Globigerina pseudobulloides/Globigerina daubjergensis zone. *Rugoglobigerina* are reworked.

K-3–K-5. Irregular alternation of compact limestone, argillaceous limestone and marls.
The rich and well preserved faunas indicate the Globigerina pseudobulloides/Globigerina daubjergensis zone.

K-5–K-6. Compact reddish limestone and argillaceous limestone.
The well preserved fauna contained in a marly layer at K-6 indicates the Globorotalia trinidadensis zone.

K-6–K-8. Well bedded, compact limestone.
A thin section from K-7 contains conicotruncate *Globorotalia*, lenticular *Globorotalia* of the *pusilla* group and flattened «*Planorotalia*». They may be attributed to the Globorotalia pusilla pusilla zone.

K-8–K-13. Thin-bedded, reddish limestone and argillaceous limestone with intercalations of red marls.
Samples K-8 and K-9 represent the Globorotalia pseudomenardii zone.
In the sample K-10, no representatives of the *Globorotalia pusilla* group or of *Globorotalia pseudomenardii* can be observed. The fauna is mainly composed of *Globorotalia acuta*.
K-10 and K-12 are comparable to the samples G-75 and G-74 of the Gubbio section (= Globorotalia velascoensis zone). In K-12, a few reworked *Globotruncana* occur.
K-13 has yielded a poor and badly preserved fauna dominated by *Globorotalia acuta*. Typical *Globorotalia velascoensis* are missing.

K-13–K-15. Well-bedded compact limestone.
The faunas within the thin marly intercalations at K-15 and K-14 are incrusted and could not be determined.

K-15–K-22a. Alternation of reddish limestone, argillaceous limestone and red marls.
K-16 and K-17 contain poorly preserved faunas with *Globorotalia aequa*, *Globorotalia subbotinae* and *Globorotalia formosa gracilis*.
Level K-18 has furnished a poor and crushed fauna, which is indeterminable.
K-20 contains exclusively specimens of small size.
A well preserved fauna, mainly of *Globorotalia subbotinae*, is present in sample K-21.
The rich and well preserved faunas of K-22 and K-22a are composed of *Globorotalia subbotinae*, *Globorotalia formosa formosa* and *Globorotalia formosa gracilis*.

K-22a–K-23. Irregularly thin-bedded, compact limestone.
The thin section K-23 contains mainly forms which are comparable to *Globorotalia subbotinae*.

K-24–K-32. Irregular alternation of compact reddish limestone, argillaceous limestone and rare thin beds of red marls. Reddish-brown chert nodules occur first about 0.80 m below K-31.

The sample K-24 contains *Globorotalia subbotinae* as the only representative of the keeled *Globorotalia*.

The poorly preserved faunas in samples K-25 and K-26 are indeterminable.

The well preserved fauna at K-27 is mainly composed of *Globorotalia aragonensis*. A few reworked *Hedbergella* of Albian character are present. *Globorotalia bullbrooki* (which is retained as synonymous to *Globorotalia spinuloinflata* (BANDY), 1949 by BANDY (1964)) and frequent *Globorotalia pentacamerata* are also present.

In samples K-30, K-31 and K-32, no determinable forms occur.

K-34–K-40. (Between K-32 and K-34, the section along the road is covered for a distance of 10–12 m.)

Well-bedded reddish to greenish dense limestone with layers of predominantly reddish brown chert nodules and a few irregularly distributed thin beds of red marls.

K-34 has furnished a poor fauna (*Globorotalia aragonensis, Globorotalia broedermanni*). The rich assemblage at K-35 is composed almost exclusively of *Globorotalia aragonensis* and *Globorotalia pentacamerata*, whereas *Globorotalia bullbrooki* is rare.

K-36 contains a similar and better preserved assemblage.

Samples K-38 and K-37 contain a few *Globorotalia aragonensis*.

In samples K-39 and K-40, *Globorotalia bullbrooki* dominates, whereas *Globorotalia aragonensis* is rare. K-39 contains numerous small fish teeth.

K-40–K-42. Thin-bedded greenish and reddish limestone with a few layers of reddish marls. The last chert nodules have been observed about 1 m above K-40.

Samples K-41 and K-42 are to be placed in the Globorotalia bullbrooki zone.

Along the road section on the western slope of the Valle della Contessa, the Cretaceous/Tertiary boundary is outcropping 14 m from the southern end of the bridge at Pt. 585.

The uppermost Cretaceous is represented by a well-bedded, light pink limestone which contains a rich fauna. The fauna present in a marly seam at V-80 corresponds to G-99 in the Gola del Bottaccione section. The Cretaceous/Tertiary boundary has been described by PREMOLI SILVA & LUTERBACHER (1962, 1964).

V-80–V-88. Irregularly thin-bedded red limestone and argillaceous limestone with thin layers of red marls.

The lowermost 0.5 m of the Tertiary belongs to the Globigerina eugubina zone.

V-82–V-86 contain rich and well preserved faunas of the Globigerina pseudobulloides/Globigerina daubjergensis zone.

V-87 and V-88 are attributed to the Globorotalia trinidadensis zone.

V-88–V-99. Generally well-bedded, compact, reddish limestone.

A thin section of sample V-89 shows a fauna, comparable to the basal part of the Globorotalia pusilla pusilla zone.

Between V-89 and V-90 (85 m), the measured section is interrupted by the bridge over the small river originating near S. Angelo Crepegge. The total thickness of the missing strata may be 60 m.

V-90–V-95. Alternation of reddish and greenish limestone with layers of chert nodules and thin beds of reddish marls. The uppermost layer of chert nodules occurs 1.50 m above V-93.

V-90 and V-91 contain poor and indeterminable faunas.

V-92 yielded a well preserved and rich assemblage, dominated by *Globorotalia bullbrooki*; *Globorotalia aragonensis*, however, is rare.

In samples V-93 and V-94, the faunas consist of reworked specimens from the Globorotalia aequa zone (*Globorotalia aequa, Globorotalia formosa formosa, Globorotalia subbotinae, Globorotalia marginodentata*). The reworked specimens are better preserved than the autochthonous *Globorotalia bullbrooki*.

V-95 is to be attributed to the Globorotalia bullbrooki zone.

3. Fossombrone

The section of Fossombrone is situated on the eastern flank of the Cesena anticline (see SELLI, 1954, CATI, 1962). The section described here does not correspond

to the one described by O. RENZ (1936) from near S. Lazzaro on the western flank of the same anticline. This section is at present only partly exposed, because of a recently constructed dam.

The section described hereafter has been measured in the easternmost limestone quarries, near Madonna del Sasso, south of Fossombrone, along the road Fossombrone–S. Ippolito (see sketch-map, fig. 131). The upper part of the sequence (Fo-27–Fo-40) is exposed along the trail leading to the houses at Pt. 191 and Pt. 227 on the eastern slope of the Valle del Sasso.

The Cretaceous/Tertiary boundary has been described and illustrated already by PREMOLI SILVA & LUTERBACHER (1964).

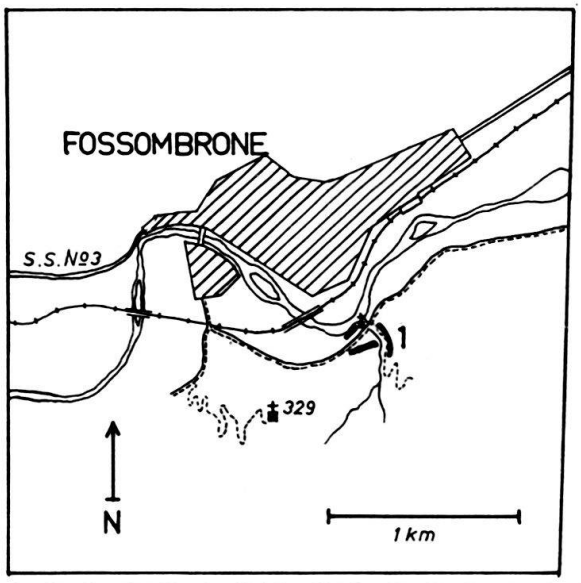


Fig. 131. Sketch-map of the region of Fossombrone with location of the studied section.

In contrast to the sections in the Gubbio anticline, where the lowermost Tertiary is complete, Paleogene starts here only with the Globorotalia trinidadensis zone. The gap in sedimentation is indicated by 1–2 cm of sandy marls with agglutinating foraminifera and numerous small teeth of fishes. A few meters below the lowermost Tertiary, a few layers show laminated bedding, indicating resedimentation.

The lowermost Tertiary is represented by about 0.80 m thin-bedded red limestone containing a fauna of the Globorotalia trinidadensis zone.

Fo-5–Fo-6. Light-coloured well-bedded reddish to yellowish limestone with a few marly seams in its upper part.

A thin section taken at Fo-5 shows a very rich fauna of conicotruncate *Globorotalia*, flattened «*Planorotalia*» and forms of the *Globorotalia pusilla* group.

Fo-6 contains a rich and well preserved fauna with *Globorotalia pusilla pusilla*, *Globorotalia chapmani*, *Globorotalia angulata*, *Globorotalia conicotruncata*, *Globorotalia tadjikistanensis* and *Globorotalia simulatilis*, which is typical for the Globorotalia pusilla pusilla zone.

Fo-6–Fo-7. Thin-bedded reddish limestone with only a few marly layers. About 0.50 m above Fo-7, a distinct layer of light limestone occurs.

The fauna of Fo-7 is attributed to the Globorotalia pseudomenardii zone.

Fo-8–Fo-9. Reddish limestone with layers of red marls. Approximately 1.5 m below Fo-8 and 4.0 m above Fo-9, two distinct beds of light-coloured limestone are present.
The assemblage of Fo-8 still belongs to the Globorotalia pseudomenardii zone, whereas the Globorotalia velascoensis zone begins at level Fo-9.

To fill the gap between the two lower quarries (Fo-9/Fo-10), a few samples have been taken along the Metauro river (Me-1–Me-11), below the road Fossombrone–S. Ippolito. The lowermost of these samples (Me-11) has been taken about 1.0 m above a distinct layer of light-coloured limestone, which correlates lithologically with a similar bed approximately 0.5 m above Fo-7.

Me-11–Me-10. Thin-bedded reddish limestone and argillaceous limestone with thin beds of red marls.
Me-11 contains a poor and badly preserved fauna of the Globorotalia pseudomenardii zone.
The poor preservation of the assemblages at Me-10 does not permit a specific determination.

Me-9–Me-7. Irregularly bedded, reddish, compact limestone with a few marly seams and rare thin beds of red marls.
The shaly marls at Me-8 and Me-9 have a reduced carbonate content and therefore furnished few and poorly preserved agglutinating foraminifera.
A thin section from Me-7 shows a few keeled *Globorotalia* of the *Globorotalia aequa* group.

Me-1–Me-5. Thin-bedded, reddish limestone and red marls. The relatively rich, but poorly preserved faunas from samples Me-1 and Me-2 are attributed to the Globorotalia aequa zone.
The assemblages from Me-3 and Me-4 are too poorly preserved to be determined.
In the sample Me-5, *Globorotalia* are represented almost exclusively by *Globorotalia subbotinae.*

Me-5–Me-6. Reddish to greenish well-bedded limestone. The first layer of chert nodules is observed 0.80 m below the pale red marls at Me-6.
The fauna of Me-6 contains numerous *Globorotalia aragonensis* and scarcely *Globorotalia subbotinae, Globorotalia pentacamerata* and *Globorotalia bullbrooki.* Me-6 corresponds lithologically and faunistically to Fo-16.

The measurement of the section has been continued at the base of the second quarry. Its lowermost 10 m correspond to the top of the strata measured along the Metauro river.

Fo-10–Fo-15. Generally well-bedded reddish to greenish limestone with a few thin layers of red to pale red marls.
The faunas at levels Fo-10, Fo-11 and Fo-12 are poor and badly preserved and could not be determined.
Sample Fo-13 has yielded a rich, but generally crushed assemblage with *Globorotalia aragonensis* and *Globorotalia subbotinae,* whereas the faunas of Fo-14 and Fo-15 are again indeterminable.

Fo-16–Fo-26. Well-bedded reddish and greenish limestone with irregularly scattered layers of reddish, brown and green chert nodules. Layers of predominantly pale reddish marls are rare and irregularly scattered. The last layer of pale-greenish chert nodules is situated 2.0 m above level Fo-25. The top of the quarry is formed by well-bedded reddish to greenish limestone, which becomes predominantly reddish and intercalated with a few layers of red marls in its uppermost 3.0 m.
Fo-16 contains the same fauna as Me-6 and is placed in the basal part of the Globorotalia aragonensis zone.
Sample Fo-17 has yielded a fauna which is almost exclusively composed of «*Acarinina*», whereas keeled *Globorotalia* are rare.
The faunas from the levels Fo-18, Fo-19 and Fo-20 belong to the Globorotalia aragonensis zone.
The samples Fo-12, Fo-23 and Fo-25 have not furnished determinable forms; only in Fo-22 and Fo-24 may a few *Globorotalia bullbrooki* and rare *Globorotalia aragonensis* be recognized.
The last sample at the top of the quarry, Fo-26, contains a relatively rich fauna, indicating the Globorotalia bullbrooki zone. Some of the *Globorotalia pentacamerata* and *Globorotalia aragonensis* may be reworked, because they are differently coloured.
The section is continued along the trail on the left slope of the Valle del Sasso.

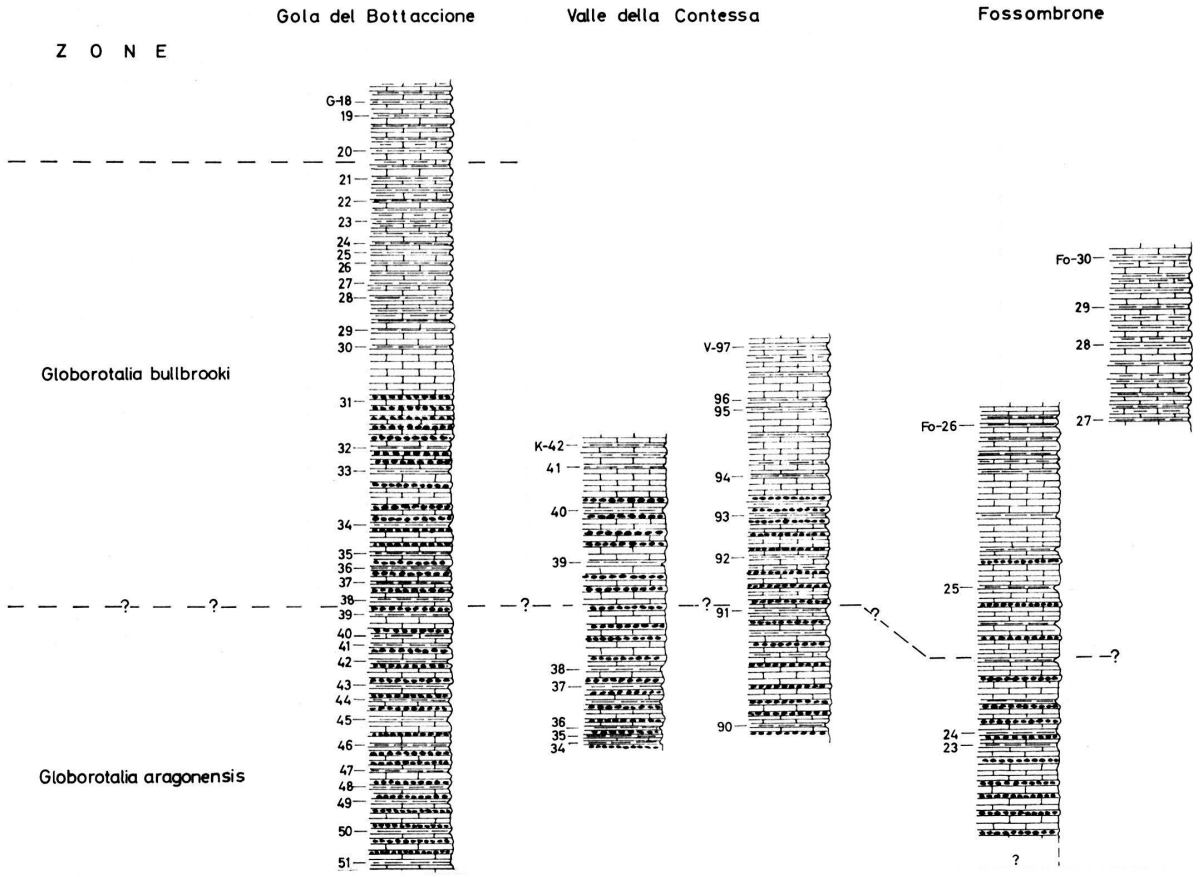
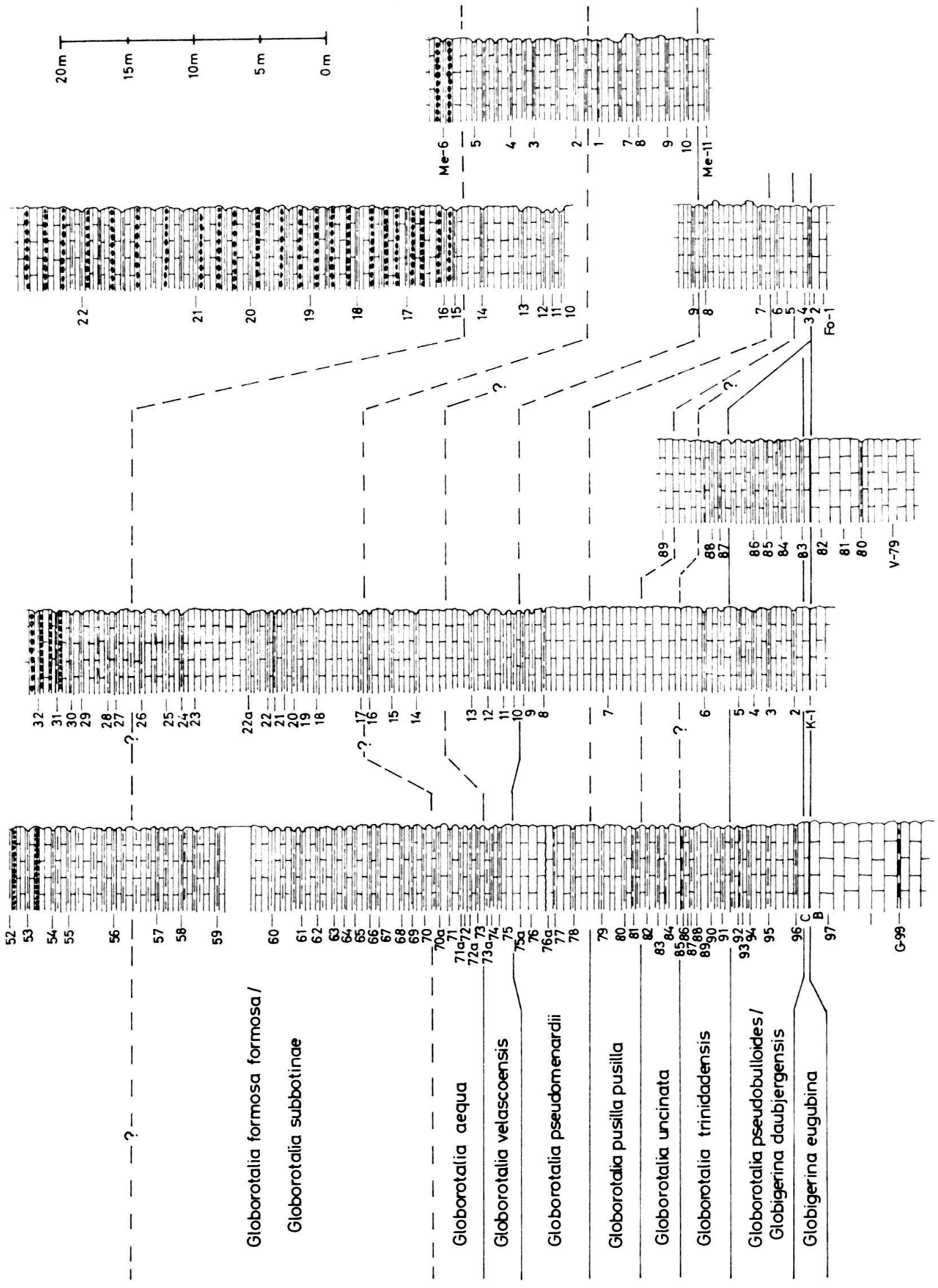


Fig. 132. Columnar sections of the Paleocene and Lower Eocene of the Scaglia, Central Apennines.


20m
15m
10m
5m
0m
Me-6
Me-11
Fo-1
K-1
V-79
G-99
Globorotalia formosa formosa /
Globorotalia subbotinae
Globorotalia aequa
Globorotalia velascoensis
Globorotalia pseudomenardii
Globorotalia pusilla pusilla
Globorotalia uncinata
Globorotalia trinidadensis
Globorotalia pseudobulloides /
Globigerina daubjergensis
Globigerina eugubina

Fo-27–Fo-30. Regular alternation of reddish limestone, argillaceous limestone and red marls. The fauna of sample Fo-27 corresponds to that of Fo-26. Within the levels Fo-28, Fo-29 and Fo-30, *Globorotalia bullbrooki* prevails, whereas *Globorotalia aragonensis* is less frequent. In the well preserved fauna from Fo-30, *Globorotalia pseudotopilensis* and *Aragonia anauna* may be mentioned.

A comparison of the three measured sections shows little differences in lithology and thickness. The Scaglia is very uniform in its general aspect.

A detailed knowledge of the biostratigraphy of the Scaglia, however, indicates a more vivid history of the basin and details may differ considerably over short distances.

The important differences at the Cretaceous/Tertiary boundary and the existence of gaps in sedimentation along this boundary are already described by PREMOLI SILVA & LUTERBACHER (1964).

A comparison of the thicknesses of the different zones is given in the following tabulation:

Zone	Gola del Bottaccione	Valle della Contessa	Fossombrone
Globorotalia bullbrooki	35 m	> 25 m	> 35 m
Globorotalia aragonensis	28–30 m	28–30 m	45–55 m
Globorotalia formosa formosa/Globorotalia subbotinae	22–24 m	16–18 m	10–12 m
Globorotalia aequa	4–5 m	6–7 m	8 m
Globorotalia velascoensis	2.5 m	4–6 m	
Globorotalia pseudomenardii	5–6 m	5 m	5 m
Globorotalia pusilla pusilla	4–5 m	4–5 m	2 m
Globorotalia uncinata	3 m	3 m	1.5 m
Globorotalia trinidadensis	4 m	3–4 m	
Globorotalia pseudobulloides/Globigerina daubjergensis	5–7 m	5–7 m	–
Globigerina eugubina	0.5 m	0.5–0.75 m	–

In the upper part of the three sections, a strong increase in thickness of the individual zones is observed.

In the section of the Gola del Bottaccione, the thickness of strata attributed to the Globorotalia bullbrooki zone exceeds by about 5 m the interval between the Globigerina eugubina zone and the Globorotalia aragonensis zone. In the Lower Eocene and Paleocene near Fossombrone, the discrepancy between the thicknesses of the zones is even more obvious: Globorotalia aragonensis zone 45–55 m, Globorotalia trinidadensis zone to Globorotalia aequa zone ca. 25 m.

This close succession of planktonic foraminiferal zones in the Paleocene compared with the looser succession within the Lower Eocene may have three reasons:

(a) The rate of sedimentation was considerably lower during the Paleocene than during the Lower Eocene.

(b) The evolutionary speed of planktonic foraminifera slowed down in Lower Eocene time. In the course of evolution of planktonic foraminifera, several epochs of increased «evolutionary speed» are noted. During the Upper Albian/lowermost

Cenomanian, a rapid change of short living planktonic species is observed. After the extinction of almost all planktonic foraminifera at the end of the Upper Cretaceous, a rapid evolution starts again during Paleocene time.

(c) The present knowledge of the genus *Globorotalia* during the Lower Eocene is not yet sufficient enough to allow a further splitting of zones. The author thinks that a detailed study of more sections with better preserved faunas will lead to a more perfect zonation.

The abundant reworking of older faunas in the Scaglia is another interesting fact. Reddish layers within the greenish limestones and marls of the upper part of the sections are almost always connected with reworking. The reworking of forms from the Globorotalia aequa zone within the upper part of the Globorotalia bullbrooki zone might indicate the exposition of sediments of the Globorotalia aequa zone to – probably submarine – erosion during the deposition of the Globorotalia bullbrooki zone. A better knowledge of reworking is fundamental to understand the history of the Scaglia basin.

The zonation of the Paleocene and Lower Eocene of the Central Apennines by means of planktonic foraminifera

Planktonic foraminiferal zones are in the majority assemblage- or concurrent-range zones. Only a few of these zones (e.g. Globorotalia uncinata zone, Globorotalia pseudomenardii zone) represent real range zones. Therefore, some authors (HILLEBRANDT, 1962, GOHRBANDT, 1963) have preferred to use for their zonation letters (A, B, C...) to designate the individual zones rather than species names. This author prefers to use species names for the different zones, mainly for practical, especially mnemonic reasons. Concurrent-range and assemblage zones have the advantage of not being defined by the range of only one species. They may, therefore, be recognized also if part of the characterizing assemblage is missing.

The present paper follows the zonation established by BOLLI (1957) for the Paleocene and Lower Eocene of the Lizard Springs formation in Trinidad. It has proved to be the most adequate zonation for subdividing the sections of the Scaglia basin. The correlation with BOLLI's zonation is based on the type-samples of each of his zones.

For taxonomic reasons, two minor modifications are necessary.

Towards the base of the Paleocene, two additional zones must be added: Globigerina eugubina zone and Globigerina pseudobulloides/Globigerina daubjergensis zone (see PREMOLI SILVA & LUTERBACHER. 1964). Because of its reduced thickness, the Globigerina eugubina zone might also be considered as a lowermost subzone of the Globigerina pseudobulloides/Globigerina daubjergensis zone.

Within the interval between the Globorotalia trinidadensis zone and the Globorotalia velascoensis zone, the same distribution of species may be observed in the Scaglia as in Trinidad. Minor differences are only due to a somewhat divergent interpretation of some species.

Above the Globorotalia velascoensis zone, a certain discrepancy with the zonation as introduced by BOLLI exists. As stated in the systematic part, *Globo-*

rotalia «rex» in BOLLI (1957) differs markedly from *Globorotalia rex* as described by MARTIN.

The abrupt change in the composition of both planktonic and benthonic foraminiferal faunas at the boundary between the Upper and the Lower Lizard Springs formation (southwestern Trinidad), suggests the presence of a gap in sedimentation between the Globorotalia velascoensis zone and the Globorotalia «rex» zone in this region. According to oral communication by Dr. KUGLER, this assumption may be supported by the lithology.

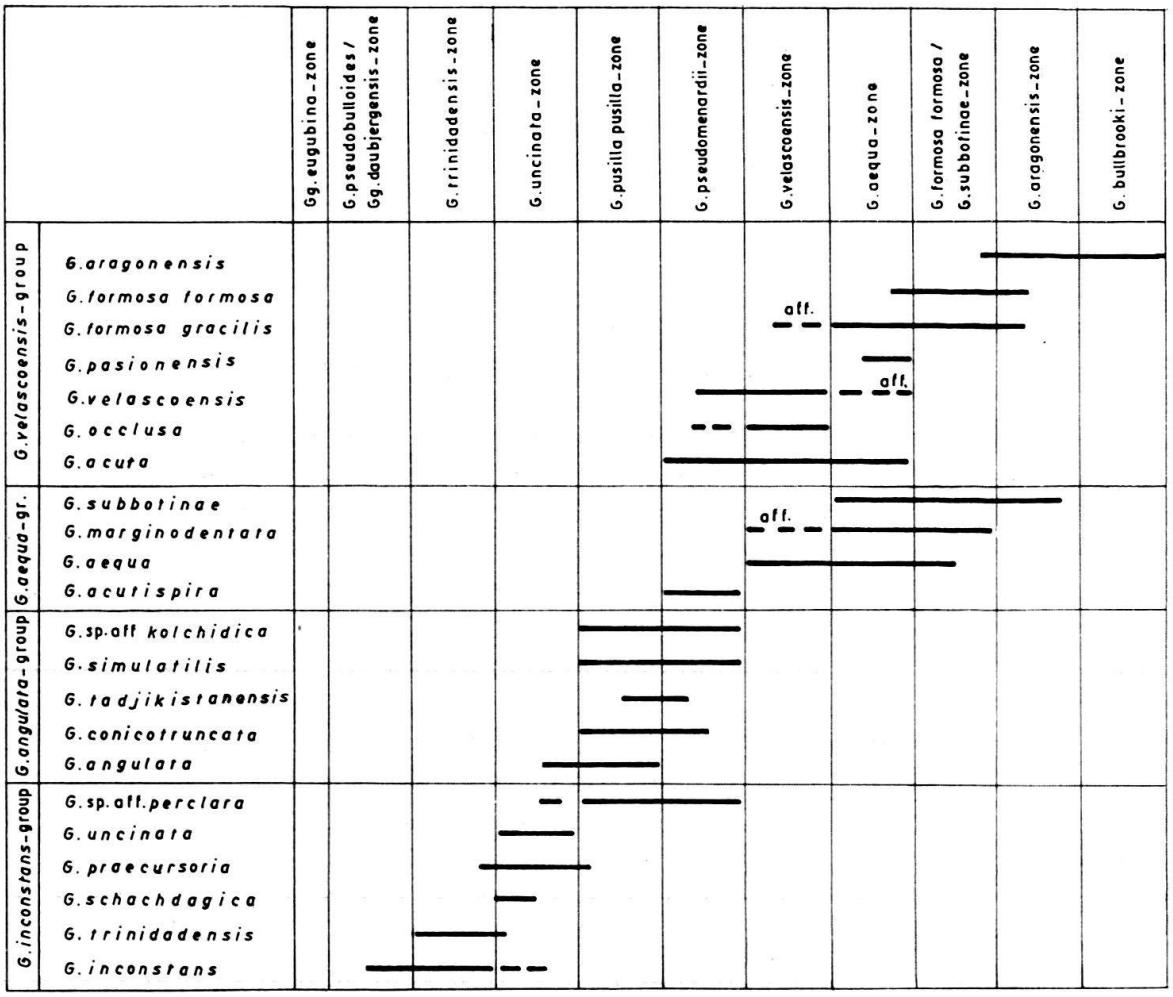


Fig. 133. Species distribution of the studied *Globorotalia* in the Paleocene-Lower Eocene of the Gubbio section, Central Italy.

The Globorotalia aequa zone is characterized by the presence of *Globorotalia aequa, Globorotalia acuta, Globorotalia* sp. aff. *velascoensis, Globorotalia marginodentata, Globorotalia formosa gracilis,* and *Globorotalia subbotinae.* In its upper part, *Globorotalia formosa formosa* appears.

The type-sample of the Globorotalia «rex» zone of BOLLI belongs to the Globorotalia aequa zone. The type-sample of *Globorotalia aequa* from the Soldado Rock (KUGLER, 1938, CUSHMAN & RENZ, 1942) represents the basal part of this zone.

The Globorotalia formosa formosa zone of BOLLI is correlated with the Globorotalia formosa formosa/Globorotalia subbotinae zone as used in the present paper. Because of the scarcity of *Globorotalia formosa formosa* in the sections of the Central Apennines, especially in that of Fossombrone, the more frequent *Globorotalia subbotinae* has been added to *Globorotalia formosa formosa* to designate this zone. The limits towards the neighbouring zones are indistinct. BOLLI & CITA (1960) and PREMOLI SILVA & PALMIERI (1962) found similar difficulties when establishing the zonation of corresponding parts of sections in Northern Italy.

The Globorotalia aragonensis zone is characterized by the presence of abundant *Globorotalia aragonensis* and *Globorotalia bullbrooki*. Some samples from this zone are flooded with *Globorotalia pentacamerata*. In the Scaglia, *Globorotalia bullbrooki* appears already in the upper part of the Lower Eocene, whereas BOLLI mentions this species only from the lower Middle Eocene of Trinidad. A similar extension of the stratigraphical range of *Globorotalia bullbrooki* (= *Globorotalia spinuloinflata*, following BANDY, 1964) has also been observed by PREMOLI SILVA & PALMIERI (1962) in the sections of the Val di Non (Alto Adige).

The Globorotalia bullbrooki zone is correlated with the Globorotalia «crassaformis» zone of the Soviet authors. *Globorotalia crassaformis*, as interpreted by SUBBOTINA (1953), is synonymous to *Globorotalia bullbrooki* BOLLI, which is a somewhat homomorphous form of the Pleistocene *Globorotalia crassaformis* GALLOWAY & WISSLER. The name Globorotalia bullbrooki/Globorotalia aragonensis zone was used by BRÖNNIMANN & RIGASSI (1963) for the uppermost zone of the Lower Eocene from Cuba. Since *Globorotalia palmerae* has not yet been found in the sections of the Central Apennines, it is not possible to use the term Globorotalia palmerae zone, although the Globorotalia bullbrooki zone might correspond to it at least partly.

On the stratigraphic subdivision of the Paleocene and Lower Eocene

The still doubtful correlations established between the planktonic foraminiferal zonation and the stages of the Paleocene have already been discussed in a previous paper (PREMOLI SILVA & LUTERBACHER, 1964), which should be referred to for more detailed discussions.

The planktonic foraminifera of the stratotype of the Danian are well known through the papers of BRÖNNIMANN (1952), TROELSEN (1957), HOFKER (1960, 1962, etc.) and BERGGREN (1960, 1962). The faunas correspond to the Globigerina pseudobulloides/Globigerina daubjergensis zone and to the lower part of the Globorotalia trinidadensis zone. *Globorotalia trinidadensis* itself is not yet recorded from the type-Danian, from which it is likely to be missing for ecological reasons. The occurrence of *Globorotalia compressa* and *Globorotalia* sp. aff. *reissi* (see BANG, 1962) allows, nevertheless, a tentative correlation of the uppermost type-Danian with the Globorotalia trinidadensis zone.

In the central part of the Northern Caucasus, the Danian corresponds to the Kuban horizon, which is attributed to the Globigerina pseudobulloides/Globigerina daubjergensis zone (LEONOV & ALIMARINA, 1961, ALIMARINA, 1963, SHUTZKAYA, 1962). This correlation by planktonic foraminifera is proved by the occurrence of

macrofossils (e.g. MOSKVIN & NAIDIN, 1960). The lower part of the overlying Elburgan svita is placed in the Upper Danian by MOSKVIN & NAIDIN (1960). Following SHUTZKAYA (1962), it corresponds to the upper part of her Globorotalia compressa/Globigerina daubjergensis/Globigerina trivialis zone and to the «Acarinina» inconstans zone. The latter zone compares approximately with the lower part of the Globorotalia trinidadensis zone[5]). ALIMARINA (1963) subdivided the «Acarinina» inconstans zone into two subzones: «Acarinina» indolensis zone and «Acarinina» praecursoria zone. The second zone is likely to correpond to the Globorotalia uncinata zone.

LOEBLICH & TAPPAN (1957) erroneously considered the type-Montian to be contemporaneous to the type-Danian. In southwestern Crimea, in the region of Bakhtchissaray, the superposition of layers corresponding to these two stages is well exposed. Here, faunas of undoubtedly Danian age are overlain by limestones containing macro- and microfaunas identical to those of the «Calcaire de Mons» (MURATOV & NIEMKOV, 1960, MOSKVIN & NAIDIN, 1960, SHUTZKAYA, 1960).

Two possibilities for drawing the limit between Danian and Montian have been proposed by MOSKVIN & NAIDIN:

(a) above the top of the layers with *Protobrissus tercensis* and *Coraster ansaltensis*;

(b) below these layers and above those with *Cyclaster gindrei* and *Protobrissus depressus*.

According to the second proposition, adopted in this paper, the Danian corresponds to the interval of *Hercoglossa danica* or to the type-section of the Danian in Denmark. Following SHUTZKAYA (1962), the layers with *Protobrissus tercensis* correlate with planktonic faunas containing «*Acarinina*» *inconstans*, «*Acarinina inconstans uncinata*», rare *Globorotalia angulata* and other species. According to the opinion of the present writer, these faunas compare with the upper part of the Globorotalia trinidadensis zone and with the Globorotalia uncinata zone.

The upper part of the Elburgan svita corresponds to the Inkerman stage, correlating to the type-Montian. (LEONOV (1963) prefers to correlate the «Inkerman stage» of southwestern Crimea with the lower part of the Elburgan svita. In the section of Bakhtchissaray, a gap in sedimentation between the «Inkerman stage» and the «Katchinsk stage» would probably correspond to the upper part of the Elburgan svita.) SUBBOTINA (1953) placed the upper part of the Elburgan svita in her «zone of rotaloid Globorotaliids», which she assumed to be of Danian age. SHUTZKAYA (1962) subdivided this part of the Elburgan svita into two zones: Globorotalia angulata zone and Globorotalia conicotruncata zone; whereas ALIMARINA (1963) shows it to belong mainly to her «Acarinina» angulata subzone and to the lowermost part of the subzone with «*Acarinina*» *conicotruncata*, rounded «*Acarinina*» *tadjikistanensis* (= *Globorotalia tadjikistanensis djanensis*) and *Globorotalia kolchidica*. KOROBKOV (in SHUTZKAYA, 1956) correlated the upper part of the Elburgan svita with the Montian.

The faunas of the «Acarinina» angulata zone correspond to the uppermost part of the Globorotalia uncinata zone and the lower part of the Globorotalia pusilla

[5]) Correlations with faunasfrom the southern Soviet Union are mainly based on samples obtained from V. A. KRASHENNINIKOV, N. N. SUBBOTINA, E. K. SHUTZKAYA, N. I. MASLAKOVA, D. P. NAIDIN and G. I. NIEMKOV.

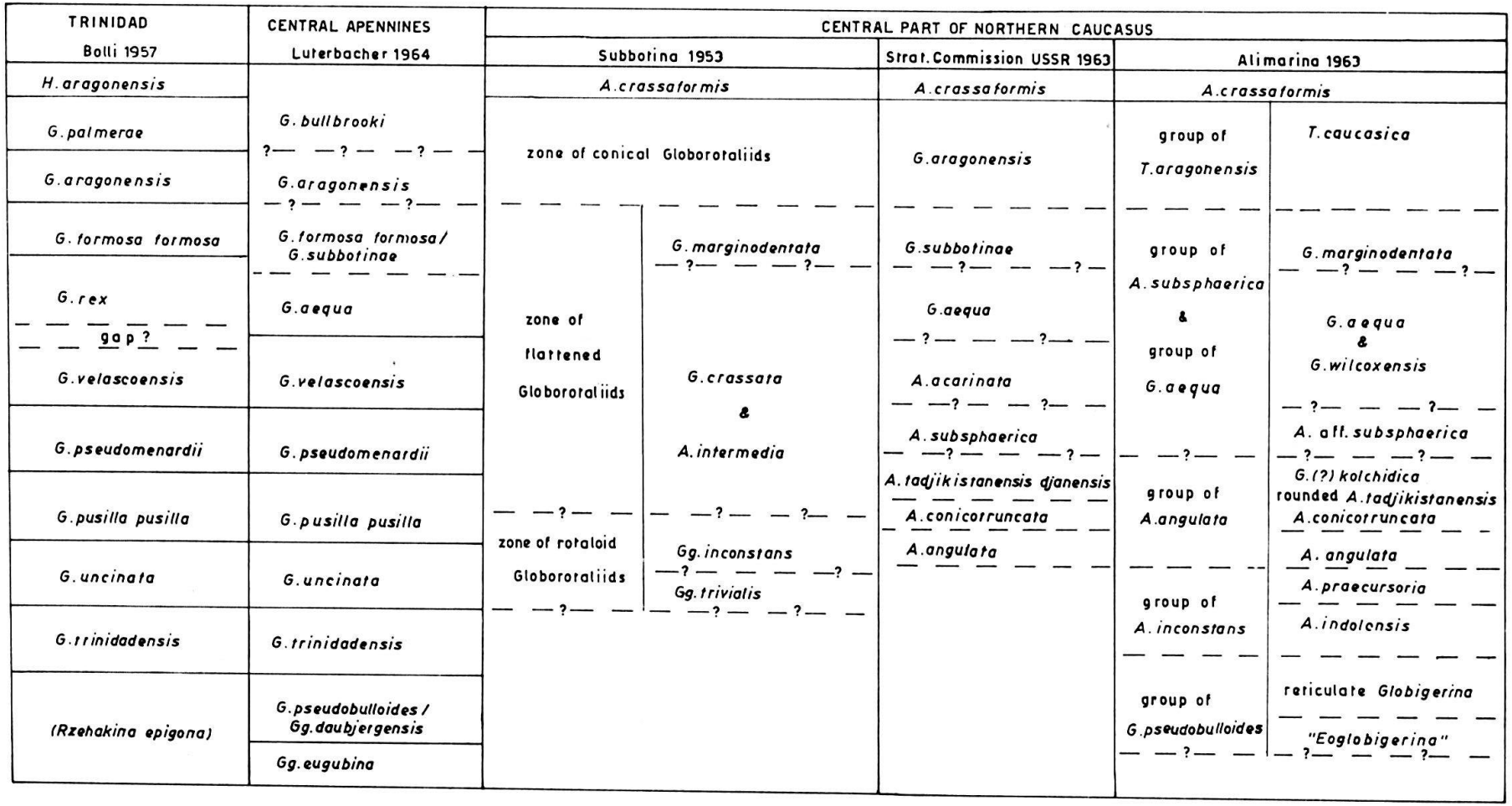


Fig. 134. Correlation of some biostratigraphic zonations of the Paleocene-Lower Eocene by means of planktonic foraminifera (partly after KRASHENINNIKOV, personal communication).
(*G.* = *Globorotalia*, *Gg.* = *Globigerina*, *H.* = *Truncorotalia*, *A.* = *Acarinina*.)

pusilla zone. The Globorotalia conicotruncata zone is entirely placed in the Globorotalia pusilla pusilla zone.

In the «Decision of the Stratigraphic Commission on the Paleogene of the USSR», the overlying «Acarinina» tadjikistanensis djanensis zone and the «Acarinina» subsphaerica zone of the Goriatchy Kliutch svita are attributed to the Katchinsk stage, which is said to correspond to the Thanetian of Western Europe. (Following LEONOV (1963), in the stratotypical section of Bakhtchissaray, only layers corresponding to the «Acarinina» tadjikistanensis djanensis zone would be represented. He considers the possibility of a gap in sedimentation within this section, which may represent the interval between the «Acarinina» subsphaerica zone and the Globorotalia aequa zone of the Kuban section in the Northern Caucasus.) A comparison of the faunas from the «Acarinina» tadjikistanensis djanensis zone (=approximately «Acarinina» conicotruncata, rounded «Acarinina» tadjikistanensis, Globorotalia (?) kolchidica zone in ALIMARINA, 1963) with faunas from Trinidad and the Central Apennines is somewhat difficult. Although the fauna is still very rich in individuals, it is already impoverished in its specific content. This may be caused by the predominance of an uncalcareous facies in the Goriachi Kliutch svita. The «Acarinina» tadjikistanensis djanensis zone is tentatively correlated with the upper part of the Globorotalia pusilla pusilla zone and the lower part of the Globorotalia pseudomenardii zone. Species with well developed keel (e.g. *Globorotalia acuta, Globorotalia acutispira*), which are to be expected within this stratigraphical level, are missing. *Globorotalia pseudomenardii* is very rare, and forms of the *Globorotalia pusilla* group – always abundant in the corresponding faunas of the Thetys faunal province – have not been found in the samples from southern Soviet Union.

The «Acarinina» subsphaerica zone contains a very specialized fauna of rounded «Acarinids». This fauna is difficult to correlate with the zonation used in the present paper. Among species characteristic for this zone are *Globorotalia velascoensis, Globorotalia apanthesma* and *Globorotalia pseudomenardii* («Stratigraphic Commission,» 1963). They have not been observed within the examined samples. The occurrence of these species allows to correlate the «Acarinina» subsphaerica zone with the upper part of the Globorotalia pseudomenardii zone.

The presence of Discoasterids of the Heliolithns riedeli zone (BRAMLETTE & SULLIVAN, 1961) in the type-Thanetian and in the type-sample of the Globorotalia pseudomenardii zone in Trinidad, indicates the Thanetian age of the lower part of this zone. This correlation corresponds satisfactorily to the conclusions reached by LEONOV & ALIMARINA (1961).

In 1960, HOTTINGER & SCHAUB introduced the term Ilerdian as a stage name for the Upper Paleocene. Its validity is still wide open to discussion. Several stipulations for the establishment of a new «time-stratigraphic unit» – as specified by the «Code of Stratigraphical Nomenclature» – are not yet satisfied. In its type-region, the Ilerdian is limited at its base and at its top by continental sediments, and therefore its relations to the Thanetian and the Cuisian cannot be observed. Planktonic foraminifera (GARTNER & HAY, 1962) cannot be used for correlation. Reworking is frequently observed in this extremely epicontinental section.

In the classic section of El Quss Abu Said (Farafrah Oasis, Western Egypt), the first *Nummulites*, marking the beginning of the Ilerdian, appear within the Globorotalia pseudomenardii zone. This zone contains an assemblage of Discoasterids of the Discoaster multiradiatus zone, as in its upper part in the Velasco formation (Eastern Mexico). In the section of the Schlierenflysch (Central Switzerland), the earliest *Nummulites* appear within the same Discoaster zone. The Globorotalia pseudomenardii zone therefore corresponds to the uppermost Thanetian and to the lowermost Ilerdian.

In the «parastratotype» section of the Kuban-river, lowermost Eocene (Bakhtchissaray stage) begins with the «Acarinina» acarinata zone (lower part of the Abazinsk svita). The fauna of this zone differs considerably from faunas of the Thetys. It is not attempted to correlate this zone with the zonation used in the present paper. The upper part of the Abazinsk svita (= Globorotalia aequa zone) corresponds in its faunal composition to the homonymous zone of the Central Apennines. In samples from the Northern Caucasus, heavily keeled *Globorotalia acuta* and similar forms have not been observed. LEONOV & ALIMARINA (1961) correlated the Labinsk group (upper part = Abazinsk svita) with the Globorotalia velascoensis zone and the Globorotalia «rex» zone of Trinidad. SUBBOTINA (1953) placed the Abazinsk svita in the Globorotalia marginodentata subzone, whereas SHUTZKAYA (1956, 1960) mentioned the following characteristic species for these layers (= upper part of the Naltchik horizon): «*Acarinina*» *subsphaerica*, «*Truncorotalia*» *praenartanensis*, *Globorotalia densa* and *Globorotalia membranacea*. KOROBKOV (in SHUTZKAYA, 1956) correlated the upper part of the Naltchik horizon with the Ypresian.

In the stratotype section of Bakhtchissaray (southwestern Crimea), the Globorotalia aequa zone is placed in the Operculina semiinvoluta subzone, which is characterized also by *Nummulites mouratovi* and *Nummulites globulus* (MURATOV & NIEMKOV, 1960). In the Schlierenflysch section (Central Switzerland), *Nummulites globulus* ranges from Middle Ilerdian to Lower Cuisian (SCHAUB, 1951).

The type sample of the Globorotalia velascoensis zone in Trinidad is placed by HAY in the Discoaster multiradiatus zone and has therefore to be attributed to the Lower Ilerdian. In the section of Paderno d'Adda (Northern Italy, BOLLI & CITA, 1960), a breccia within the Globorotalia velascoensis zone contains *Nummulites exilis*, which is characteristic for the Middle Ilerdian.

The Lower and Middle Ilerdian can be correlated by quite good arguments with planktonic foraminiferal zones. Approaching the Upper Ilerdian and the Lower Cuisian, the relations are more confused. (These stratigraphical terms are used as defined by HOTTINGER & SCHAUB, 1960.)

Nummulites, indicating a Lower Cuisian age, are interbedded in the Paderno d'Adda section (level 9 in VIALLI, 1951) in a planktonic fauna, attributed – with some restrictions due to poor preservation – to the Globorotalia aequa zone (see BOLLI & CITA, 1960). In the condensed and incomplete sequence of Valdeforte (Northern Italy, CITA, BOLLI & SCHAUB, 1962), Lower Cuisian *Nummulites* and *Alveolina* are associated with planktonic foraminifera of the Globorotalia «rex» zone. In both localities, thin sections demonstrate that larger and planktonic foraminifera are embedded in a different matrix.

On the other hand, the type-sample of the Globorotalia «rex» zone in Trinidad is to be placed, according to HAY, in the Discoaster contortus zone. In the Schlieren section, this zone contains *Nummulites* of the Middle Ilerdian.

In the section of El Quss Abu Said, faunas of the Globorotalia aequa zone occur in the upper Farafrah shales, below the Maqfi beds, the latter containing *Nummulites* and *Alveolina* of Middle to Upper Ilerdian.

The Globorotalia aequa zone apparently reaches from Middle Ilerdian to lowermost Cuisian. It straddles over the Paleocene/Eocene boundary as interpreted by HOTTINGER & SCHAUB.

SHUTZKAYA (1956, 1960) and ALIMARINA (1963) place this boundary above the Abazinsk svita and consequently above the Globorotalia aequa zone. In the «Decision of the Stratigraphical Commission», the Globorotalia aequa and the «Acarinina» acarinata zones are already placed in the Lower Eocene.

In the clay pit of the «Tuilerie de Gan» (southwestern France), a well preserved planktonic fauna, which is placed in the Globorotalia formosa formosa/Globorotalia subbotinae zone, is present in the middle part of the section. The same layers are dated as uppermost part of Lower Cuisian by larger foraminifera.

In the region of Haimana (Anatolia, Turkey, see HOTTINGER, 1962), a rich and well preserved fauna, which strikingly resembles faunas of the Globorotalia subbotinae zone from the Northern Caucasus, is overlain by *Alveolina*, indicating a Lower Cuisian age. Although differences in the specific composition of the fauna cannot be denied, the Globorotalia subbotinae zone of SHUTZKAYA (1956, 1960) might be correlated with the Globorotalia formosa formosa/Globorotalia subbotinae zone, as done in this paper. Contemporaneous deposits are placed by ALIMARINA (1963) in her Globorotalia marginodentata subzone.

In southwestern Crimea, the Globorotalia subbotinae zone is placed in the upper part of the Bakhtchissaray stage, which contains *Nummulites* of Lower Cuisian age (Nummulites planulatus zone).

The Globorotalia aragonensis zone of Soviet authors corresponds satisfactorily to the homonymous zone of BOLLI. By decision of the Stratigraphical Commission (1963), this zone forms the lower part of the Simferopol stage, which is characterized by *Nummulites* of Upper Cuisian age in the section of Bakhtchissaray. It does not correspond to the Lutetian of the Paris Basin, as supposed by Soviet authors (NIEMKOV & BARKHATOVA, 1959, «Decision of the Stratigraphical Commission», 1963).

The rich and well preserved faunas of the «Marnes de Donzacq» (southwestern France) with *Globorotalia aragonensis* and *Globorotalia caucasica* are retained as Upper Cuisian by HOTTINGER & SCHAUB (1960). LEHMANN (personal communication) has found a fauna with *Globorotalia aragonensis* and *Globorotalia caucasica* overlain by deposits with *Nummulites* indicating Upper Cuisian. In the Erevan basin (Armenian SSR) GABRELYAN, SAHAKYAN & MARTIROSYAN (in MENNER, 1960) reported a similar occurrence of *Globorotalia aragonensis* and *Globorotalia caucasica* below layers with *Nummulites murchisoni*.

The Globorotalia bullbrooki zone, as used in the present paper, at least in part corresponds to the Globorotalia palmerae zone and to the «Acarinina crassaformis»

zone of Soviet authors (SUBBOTINA, 1953, SHUTZKAYA, 1956, 1960, ALIMARINA, 1963, KRASHENINNIKOV & PONIKAROV, 1964).

CITA, BOLLI & SCHAUB (1962) described from Cerbiolo (Monte Baldo, Northern Italy) a planktonic fauna of the Globorotalia palmerae zone, which is dated by *Nummulites* as topmost Cuisian. In the «Decision of the Stratigraphical Commission» (1963), the «Acarinina crassaformis» zone is placed in the upper part of the Simferopol stage, which – in southwestern Crimea – corresponds to the Nummulites polygyratus zone. Following SCHAUB, *Nummulites polygyratus* indicates topmost Cuisian. It is therefore assumed that the Globorotalia bullbrooki zone begins in the uppermost Cuisian.

Contrary to this assumption, the correlation chart given in the introduction to the symposium on the Paleogene deposits of the Southern part of the European Soviet Union (MENNER, 1960) shows a «Truncorotalia» aragonensis zone, linked with *Nummulites laevigatus* (= Lower Lutetian) and, moreover, an «Acarinina crassaformis» zone correlated with a Nummulites perforatus zone (upper Middle Eocene).

An attempt to correlate the planktonic foraminiferal zones with the stages of the Paleocene and the Lower Eocene is given in the following chart:

		Planktonic foraminiferal zone	Stage (after HOTTINGER & SCHAUB)
EOCENE	MIDDLE	Globorotalia bullbrooki	«Lowermost Lutetian»
	LOWER	Globorotalia aragonensis	«Cuisian»
		Globorotalia formosa formosa/Globorotalia subbotinae	
PALEOCENE	UPPER	Globorotalia aequa	«Ilerdian»
		Globorotalia velascoensis	
	MIDDLE	Globorotalia pseudomenardii	«Thanetian» «Montian»
		Globorotalia pusilla pusilla	
		Globorotalia uncinata	
	LOWER	Globorotalia trinidadensis	«Danian»
		Globorotalia pseudobulloides/Globigerina daubjergensis	
		Globigerina eugubina	

On account of the historic development of stratigraphical geology, all type-localities of Paleogene stages have been defined in epicontinental series of the boreal faunal province. Incomplete outcrops, differences in facies and fossil content of the numerous Western European stages prevent their satisfactory definition.

One way out of this dilemma has been chosen by the «Decision of the Permanent Interdepartmental Stratigraphical Commission on the Paleogene of the USSR» (1963). Because of the non-existence of a uniform and generally accepted scale for the stratigraphical subdivision of the Paleogene, it was decided to establish

an independent stratigraphical standard scale for the Paleogene of the Soviet Union. The classical section of Bakhtchissaray in southwestern Crimea was chosen as «stratotype» for this scale. The section along the Kuban river (central part of Northern Caucasus) serves as «para-stratotype» for the pelagic facies.

This new standard scale has been recommended for general use in Europe.

Since the present paper deals only with planktonic foraminifera, it is mainly concerned with the Kuban section.

The planktonic foraminiferal faunas of the Central Northern Caucasus differ markedly from corresponding faunas of the Thetys province, although many species common to both provinces allow a limited correlation. The well known difference in planktonic foraminifera from Thetydal and Boreal faunal provinces, existing during the Upper Cretaceous, is also observed during the Paleogene (see also BANDY, 1964).

Faunas from Anatolia, Aquitania, Vicentino, the northern part of the Atlantic coast of North America and the Lodo formation in California show great affinities to the corresponding faunas of Crimea, Northern Caucasus and Western Turkmenia; whereas the faunas of the Scaglia of Central and Northern Italy, Southern Iran, Egypt, Morocco and eastern Mexico compare well with the zonation established by BOLLI in Trinidad. For different faunal provinces, different zonations have to be established.

The Goriachy Kliutch svita and the Abazinsk svita of the central Northern Caucasus are characterized by impoverished and specialized planktonic faunas, inappropriate for a stratigraphical standard of more than regional value. The same is valid for the Upper Eocene Kumsk horizon.

The stratigraphical scale of the Paleogene has to be based on the sections developed in continuous pelagic facies from the Thetys faunal province with rich planktonic faunas. It is dangerous to base a standard zonation on only one section, which is never free from local and regional peculiarities. The attempted standard zonation will be purified from local trends and abnormalities by detailed studies of more and more sections in different regions of the Thetys. In this way, a useful tool for stratigraphic work of increasing refinement will be obtained. If the present paper might be a little step towards this goal, it has attained its purpose.

A stratigraphy based on the above principles should not be encumbered by stage names connected to strato-types more or less luckily chosen. The fundamental unit of a stratigraphy, based on fossil records, is the biozone. The assignment of biozones to stratigraphical units of higher rank is in great part a convention. The author of the present paper prefers the use of neutral terms, such as Lower, Middle and Upper Paleocene, rather than the misuse of poorly defined stage names.

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