

FIRST FINDINGS OF UPPER LLANDOVERIAN (TELYCHIAN)  
GRAPTOLITES FROM THE CAMDAG AREA, NW TURKEY

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**Abstract**

The Black Shale Member of the Findikli Formation in the Camdag area consists of black to greenish gray, well-cleaved argillites with minor black siltstone interlayers. The following graptolites *Spirograptus spiralis* (Geinitz), *Spirograptus falx* (Suess), *Spirograptus grobsdorfiensis* (Hemmann), *Monoclimacis vomerina* (Nicholson), *Monograptus priodon* (Bronn), *Monograptus parapriodon* Boucek, *Monograptus (Globosograptus) mancki* Hemmann, *Monograptus curvus* Manck, *Diversograptus ramosus* Manck, *Retiolites angustidens* Elles & Wood, *Barrandeograptus pulchellus* (Tullberg) are described for the first time from this unit. This fossil assemblage indicates the *Spirograptus spiralis* Zone of the Upper Llandovery and is so far the first age data from the lower part of the Findikli Formation in NW Turkey. The detailed dating of the black shales representing a distinct anoxic litho- and biofacies in northern Gondwana/Perigondwana may have important implications for the palaeogeographic correlations during this time-interval.

**Key words:** graptolites, Llandovery, Camdag, Turkey

**Introduction.** The Palaeozoic rocks cropping out in NW Turkey (Fig. 1) are classically known as the "Palaeozoic of Istanbul" [1] or the Istanbul-Zonguldak Terrane [2]. It is suggested that this unit was part of Laurussia [1] during the Paleozoic.

The Palaeozoic rocks of the Camdag region, geographically located between Istanbul and Zonguldak terranes, were not studied in detail unless the recent study [3], which presented new stratigraphic data and conodont findings from the Upper Silurian (Pridolian) "Orthoceras Limestones".

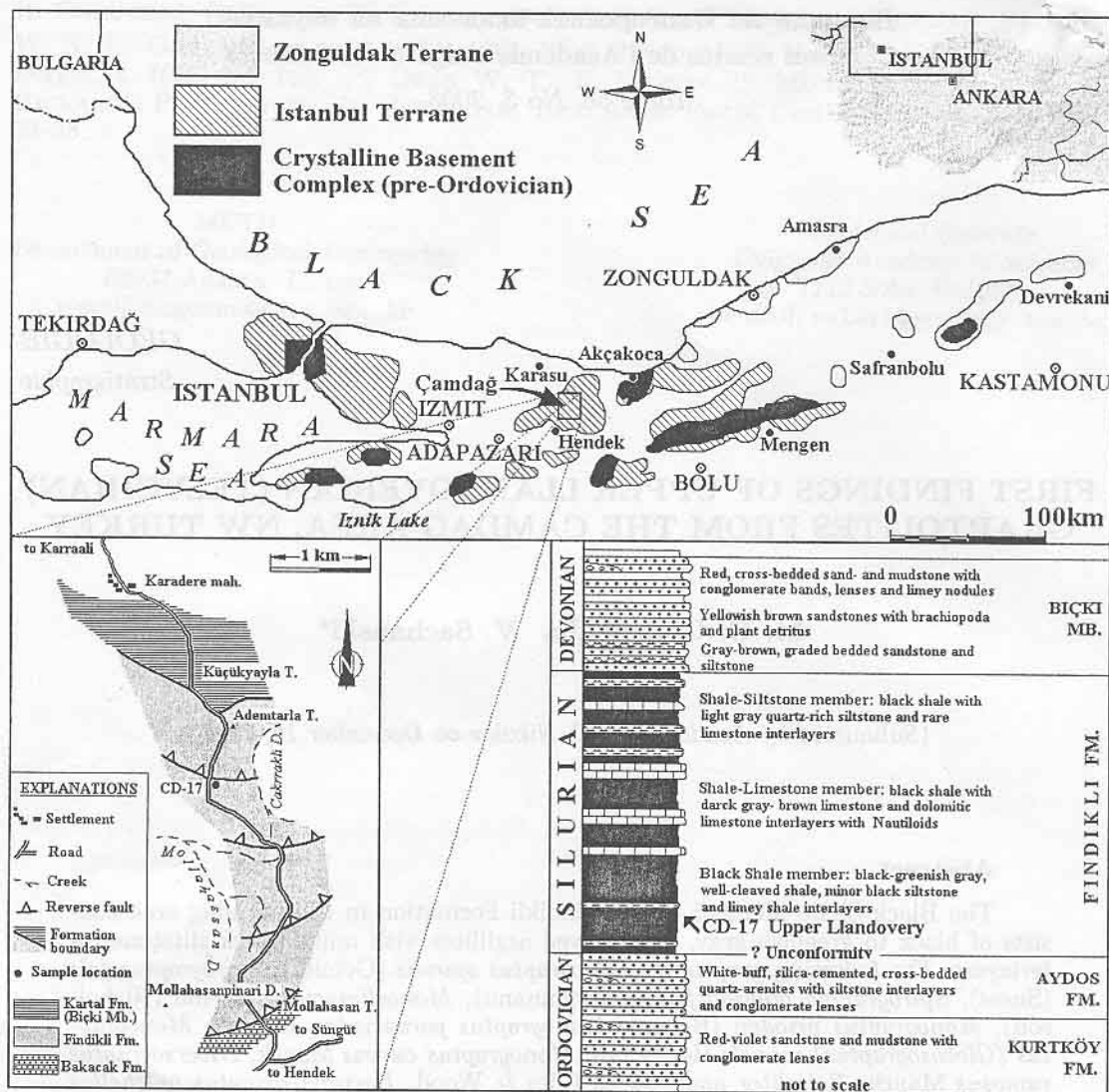


Fig. 1. Distribution of the Paleozoic rock-units in NW Anatolia, location and road-map of the study area, generalized columnar section

In the present study, the authors will present their new graptolite findings from the "Black Shale Member of the Findikli Formation" in the Camdag area. This is so far the first Early Silurian age data from the Camdag region. Based on this new fossil finding, the Lower Palaeozoic successions in the Zonguldak and Istanbul areas will be correlated and the palaeogeographic position of the Silurian rocks within the Perigondwana will be discussed.

**Geology and stratigraphy.** The Camdag "Massif" is located to the NE of Adapazari (Fig. 1). The southern part of the massif is represented by N-dipping clastic-siliciclastic rocks of Ordovician age [4]. The central and northern parts are occupied by

a roughly E-W trending anticline, dissected by numerous south-verging thrust-faults. The border between the southern and central-northern parts is an important tectonic boundary [5]. The stratigraphic details of the Palaeozoic succession are given in KOZLU et al. [3].

The studied part of the Silurian succession (Fig. 1) is located between Kurudere Village and Mollahasan Tepe on the Hendek-Karaali road. This studied succession is a part of the Silurian Findikli Formation that was recognized to the west of Camdag [6].

The contact to the underlying Ordovician rocks is a thrust-fault rather than an unconformity. The studied section (Fig. 1) starts with a thick and monotonous succession of gray to greenish gray, well-cleaved shales with minor black siltstone and limy shale interlayers, informally named as the "Black Shale Member" of the Findikli Formation [3]. The graptolite-rich sample CD-17 is from the lower 10th m of the member and includes very thin-bedded black shales alternating with gray and brownish siltstones. The succession is highly sheared and dissected by north-verging thrust-faults. It grades into black shales with limestone and dolomitic limestone interlayers (Shale-Limestone Member). The limestones are known as the "Orthoceras Limestones" and were previously assigned to Lower Devonian [6]. They are intensively folded, dark gray to brown in colour, and very rich in cephalopods, crinoids and brachiopods but also include Pridolian conodonts [3]. The upper part of the Findikli Formation is represented by an alternation of black shales, light gray quartz-rich siltstones with few limestone lenses (Shale-Siltstone Member).

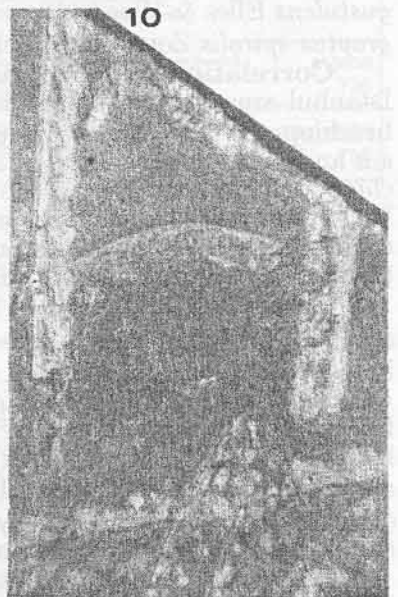
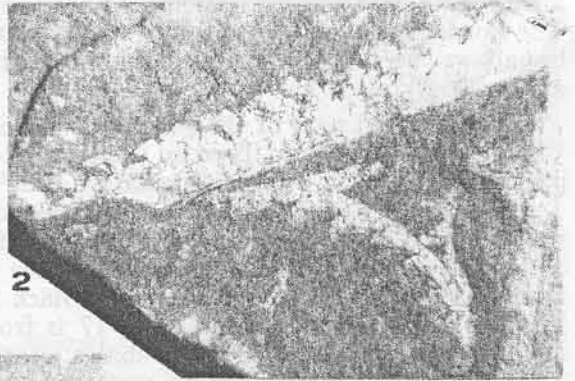
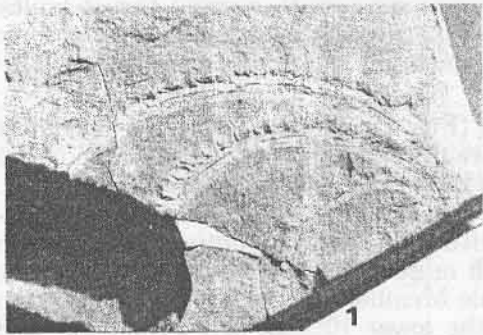
In a recent study, the authors [5] claim that they have found in the "Orthoceras Limestones" the following fossils: *Dicellograptus* cf. *complanatus* Lapworth, *Monograptus* aff. *priodon* (Bronn), and *Monograptus* sp. However, this determination was not realized by a specialist. The fact that the first form is restricted to Late Ordovician and the latter ones to Early Silurian, these determinations should be questioned.

**Silurian graptolites and age.** In sample CD-17 are determined the following graptolites (Fig. 2): *Spirograptus spiralis* (Geinitz), *Spirograptus falx* (Suess), *Spirograptus grobsdorfiensis* (Hemmann), *Monoclimacis vomerina* (Nicholson), *Monograptus priodon* (Bronn), *Monograptus parapriodon* Boucek, *Monograptus* (*Globosograptus*) *mancki* Hemmann, *Monograptus curvus* Manck, *Diversograptus ramosus* Manck, *Retiolites angustidens* Elles & Wood, *Barrandeograptus pulchellus* (Tullberg). They indicate *Spirograptus spiralis* Zone which belongs to the Upper Telychian (Upper Llandovery).

**Correlation and regional relationships.** The Llandovery rocks in the eastern Istanbul area [7] and include from bottom to top greywackes with Lower Llandovery brachiopods; arkoses, conglomerates and limestones with Upper Llandovery (c2-3) fossils and violet to green shales, alternating with chamosite-oolites, that include the brachiopods together with conodonts, indicative for Late Llandovery or earliest Wenlock. In the Bosphorus area [8] reported a quite different succession of Silurian black shales alternating with sandstones and greywackes that yielded *Monograptus rhynchoporus* (Linnarson) (original identification by G. Waterlot, Lille) indicating Late Llandovery.

In the Zonguldak terrane, Lower Silurian rocks were reported [9] in the Safranbolu area (Fig. 1). They were divided into: the lower "black argillite member", that include in its lower part *Monograptus lobiferus* (McCoy), *Rastrites* cf. *peregrinus* (Barrande), *Climacograptus* sp. and *Glyptograptus* sp., indicative of the *magnus* and *convolutus* biozones of the Aeronian Stage. Within the upper part of this member the graptolites include *M.* cf. *crispus* (Lapworth), *M. exiguus* (Nicholson) and *M. knockensis* (Elles and Wood) from the *crispus* Biozone of the Llandovery. The upper member on the other hand, are represented by gray mudstones that yielded *M.* cf. *flemingii* (Salter) and *Pristiograptus* cf. *parvus* indicating the upper half of the Wenlock Series.

Compared with the Istanbul Terrane, our new finding from Camdag area corresponds to the upper part of the Llandovery series [7]. However, the non-existence of





← Fig. 2. Graptolites from sample CD-17. 1. *Spirograptus spiralis* (Geinitz, 1842). CD-17.1; 2. *Monograptus priodon* (Bronn, 1835) and *Monograptus curvus* Manck, 1923. CD-17.12; 3. *Spirograptus grobsdorfiensis* (Hemmann, 1931). CD-17.5; 4. *Spirograptus falx* (Suess, 1851). CD-17.2; 5. *Diversograptus ramosus* Manck, 1923. CD-17.19; 6. *Retiolites angustidens* Elles & Wood, 1908. CD-17.17; 7. *Monograptus parapriodon* Boucek, 1931. CD-17.6; 8. *Monograptus (Globosograptus) mancki* Hemmann, 1931. CD-17.18; 9. *Monoclimacis vomerina* (Nicholson, 1872). CD-17.7; 10. *Barrandeograptus pulchellus* (Tullberg, 1883). CD-17.4. 1 × 3, 2 – 10 × 6

coarse clastics and shales with chamositic interlayers in the Camdag area may indicate a deeper depositional environment in the Camdag area. This interpretation is further supported by the formation of the Late Silurian nautiloid limestones in the Camdag area. A correlation with the corresponding rock-units in the Zonguldak Terrane, on the other hand, suggests that during the Early Silurian both in the Camdag and Safranbolu areas similar depositional conditions prevailed.

Another important implication of the present finding is the similarity of the Lower Silurian successions in the Istanbul-Zonguldak terrane and in the Gondwana-derived terranes. The Lower Silurian black, graptolite-bearing shales in the Istanbul-Zonguldak Terrane are representatives of an anoxic litho- and biofacies. They are also found in the Kemer area, western Taurides [2], in North Africa and in southern Europe. By this, the formation of this specific litho- and biofacies in the Istanbul-Zonguldak Terrane may suggest that it was in a similar palaeogeographic position with some Gondwanan terranes such as Taurides, Arabia, Avalonia and Bohemia.

**Conclusions.** The “Black Shale Member” within the lower part of the Findikli Formation in the Camdag area, NW Turkey include the graptolites *Spirograptus spiralis* (Geinitz), *Spirograptus falx* (Suess), *Monoclimacis vomerina* (Nicholson), *Monograptus priodon* (Bronn), *Monograptus parapriodon* Boucek, *Monograptus (Globosograptus) mancki* Hemmann, *Diversograptus ramosus* Manck, *Retiolites angustidens* Elles & Wood, *Barrandeograptus pulchellus* (Tullberg). This assemblage is indicative for *Spirograptus spiralis* Zone.

This is so far the first Late Llandoveryan age data from the Palaeozoic succession of the Camdag region, which has a transitional position between the Istanbul and Zonguldak areas. A correlation with the Istanbul and Zonguldak areas indicate that during the Lower Silurian both areas were on a similar setting within the Lower Palaeozoic basin, the Camdag and the Safranbolu-Zonguldak areas being in a more internal position than the Istanbul area.

The regional correlation with the other Gondwanan/Perigondwanan terranes (e.g. Taurides and Arabia), on the other hand, suggests a similar palaeogeographic setting of these terranes within the northern Gondwana margin.

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