ZBIGNIEW BUKOWSKI

REMARKS ON ARCHAEOLOGICAL UNDERWATER RESEARCH
BASED ON THE EXAMPLE OF A SETTLEMENT WITHIN THE
LAKE PIŁAKNO, MRĄGOWO DISTRICT (NORTH-EASTERN POLAND)

INTRODUCTORY REMARKS

Underwater archaeological research concerning a grate settlement of
an early La Tène period, situated within the lake Piłakno, Mrągowo
district, (North-eastern Poland — fig. 1) had been undertaken in 1961 by
the care of the Institute of History of Material Culture of the Polish
Academy of Sciences in Warsaw. Investigations continued over 1962 had
the following purposes:

a. a practical test of various methods of underwater exploration of
archaeological objects with detailed documentation,
b. the discovery and examination of a fragment of the settlement.

I wish in this article to share the experience acquired during two
research periods. It is to be stressed that our team was obliged to ela-
borate its own methods of underwater exploration and documentation,¹
lacking every accessible data in this matter (scientific literature was
limited to the discussion of investigated objects and gave no technical
guidance).

A BRIEF OUTLINE OF UNDERWATER RESEARCH IN POLAND

Underwater archaeological survey comprises:

a. submarine investigation tending to reveal and localize sunken
objects,
b. submarine excavation works using every accessible method and
equipment.

Although such investigations had been started many a time in Poland
and have already a certain tradition,² we possessed so far no serious
results from the Polish territory before starting work within the lake

Fig. 1. Situation of the Lake Piłakno near Rybno, district Mrągowo, Voivodship Olsztyn

- a: grate settlement; b: mounds
Pilakno. Research on a large scale had been first conducted in 1935 and 1938 in Biskupin (Żnin district). This comprised the lake's bottom around the half-isle (with fortified settlements of the Hallstatt period and early mediaeval burgs) and achieved the exact determination of the range of a Hallstatt breakwater, the finding of ceramics material, etc. Research was done by navy divers working in heavy classical diving-suits, air was supplied only by a hand pump placed on a floating platform. Investigation was very difficult owing to the fact that the divers continually blurred the water by stirring thick layers of slime covering the bottom. Thus, seeing very little, they often had to search the bottom by hand, rakes and poles.

Research was started again in 1952 and continued by excavation works in Wolin investigating the ancient port and tracing the underwater bottom of the river Dziwna's bed. Iron-concrete caissons were lowered to a considerable depth. Their rectangular basis measured 6 m. by 12 m.; they were filled with compressed air, the pressure of which increased along with the growing, depth, and reached 1,5 Atm. at 15 m. below the water's surface. In such a waterproof "bell" excavation works and photographic and designing documentation could be achieved. A diver could work inside the bell up to 4 hours according to the depth he had reached. Before coming in and after going out of the bell every workman had to spend a while within a decompressure chamber. Five caissons were lowered in order to obtain a full profile of the river Dziwna, three of which touched the river's bottom, supplying unfortunately no archaeological material. On the other hand, one of the caissons lowered near the coast allowed to discover the remains of a bridge dating from the 12th — 14th century.

Besides these investigations a penetration of the river's bottom had also been carried out in 1952 using only the equipment and devices applied formerly for underwater survey (the diver wearing a heavy diving-suit and provided with air by a hand pump fixed on a floating platform).

The attempt of a wider programme of underwater archaeological survey was undertaken in 1957 in the lakes of Central Poland. Around the village Sobiejuchy, Żnin district (20 km. south from Biskupin), below the coast of a small islet with a Lusatian Culture fortified settlement, a number of pales, the remains of a hearth and fragments of pottery etc. have been discovered. Research within the lakes around Biskupin in 1958 itself revealed a conjectured pier under the water, (also a vessel from the 13th century and wooden parts were found), and in the lake Gopło, near Kruszwica (Voivodship Bydgoszcz) partes of an early mediaeval bridge were disclosed. Very difficult conditions of exploration must
here be stressed since the bottom of the lake Gopło has a thick layer of liquid slime making penetration and every observation under the water impossible.

A group of divers carried out a second survey in Wolin in 1958, tending to localize here an early mediaeval port. Their endeavours gave no results as probably all possible remains had been destroyed by dredging the bottom of the Dziwna river, now acting as canal.

The above team achieved in the same year a preliminary recognition of the river Parsęta's bottom, along the western border of an early mediaeval burg situated close to the river's bank, today's Kołobrzeg-Budzisłowo. Several coastal stakes and pales allow to suppose here a bridge or some other way of communication across the river.⁷

Simultaneously with the research conducted in the Grunwald region (some 40 km. west of Olsztyn) in 1960, and seeking for objects connected with the battle of 1410 (against the Teutonic Order) all the neighbouring lakes have been thoroughly examined. The efforts remained fruitless as concerns the above mentioned problems. But in the lake Leszcz, near Grunwald, a kind of stone ford leading from the halfisle across the lake has been revealed. The team of divers carrying out the survey, discovered here a number of metal objects and human skeletons from the time of World War I, in spite of having no devices to the disclosing of objects and particularly metal in deep water.⁸

Investigations in the lake Lednickie (about 30 km. to the north-east of Poznań) had been started in connection with the works carried out on the island of similar name.⁹ As the archaeological expedition conducting research here possessed no ready system of that kind of investigation and had to elaborate their own method of discovery. I shall devote a few remarks to the technique of underwater research and to the results obtained.

Research had been started in 1959 by penetrating the lake in order to recognize its regions for further investigation. In 1960 our efforts were directed to the elaborating of a method of achieving measurement in underwater conditions and determining the discovered structures and single objects. Geometrical measurements for localization were done by means of two levers installed on the coast, and in the case of large objects (such as boats etc.) additional determination by means of a compass was applied.

In the course of this preliminary research the remains of two segments of a wooden bridge had been discovered: the western part was 438 m. long and the eastern one 187 m.

In 1961 regular underwater research in difficult conditions with the help of divers was started at a depth of 10 m. The limpidity of water
reached here only 3 m. and at a depth of 8—10 m. was only 1.0—1.2 m. Moreover the large amount of plankton rendered observation and photographing difficult. The lake's bottom was covered with light (half liquid) dark slime, limiting full visibility. To facilitate measurements a rope drawn from east to west was accepted as an axis blotted with marks every 5 m. Measurements and drawings were effected with the help of a grate 3 by 2 m. large (6 m²). As there were no traces of building near the coast, investigation was started at a distance of 10 m. from the coast and continued along a stretch of 26 by 3 m. (78 m²) towards the lake's centre. Every square metre was drawn by pencil under water on tarnished glass plates according to a 1 : 5 scale, then transferred to millimetre paper and joined to the general plan.

It has been stated that pales, remainders of the bridge, have persisted in the examined region only to the height of about a dozen cm. seldom jutting out above the layer of slime, whereas in the lake's middle parts they sometimes stood out by 3—5 m. The bridge built over the deepest parts of the lake (some 10.70 m. deep) had pales that measured initially up to 13 m. (when taking into account their endings one of which had been driven into the bottom and the other stood out of the water to hold the pier).

The stratigraphy of the lake's slime was further determined. The 3rd layer was recognized to be rubble and fire remnants from the time of the bridge's destruction; the 4th layer was considered to be later than the building of the bridge and the 5th containing many wooden scraps is judged to be simultaneous to its building. No relics have been found in the 6th layer.

The following findings of 1961 deserve mentioning: iron helmet of a Czech type, several iron spears, one of them inlaid with silver with a fragment of a woden handle, an iron war-axe, fragments of vessels and several whole ones dating from the 10th and 11th century, a number of tools and objects in wood, bone and iron, iron carpenter's axes probably lost during the building of the bridge. The complex of relics indicates that the bridge may most probably have been destroyed during the Czech invasion under the Prince Štětislav in 1038. Several wooden boats have also been found here, one of them, a grooved trunk 10 m. long, has been also dragged out and kept for exhibition purposes.

Divers taking part in the latter examination were well equipped (good diving suits, bottle devices containing compressed air) and could move freely under water. Scientific direction was managed by specialists in archaeology. Research was simultaneously carried out in other regions of Poland, not comprising, however, till now the Baltic coasts.

Clearing the lake Drużno near Elbląg, the purpose of which was to
discover a Prussian port Truso, mentioned in 9th century’s written sources, brought no archaeological findings. The swampy coasts and thickly overgrown banks of the lake made investigation very difficult. Also the coastal line had considerably altered in later times.

Inland research is so far limited to the penetration of lakes. That sort of survey encounters great difficulties. All rivers and lakes in the Polish territory have badly polluted water and particularly slimy bottoms. The layer of slime is often 0.5 m. thick, or even more than that, (e.g. in the Lednickie lake), which greatly hinders the finding and recognition of objects lying deep under water and requires submarine searchlights at a depth of 6—8 m.

**GEOMORPHOLOGICAL CONDITIONS OF THE PIŁAKNO LAKE**

The lake Piłakno situated in the western part of Mazurian Lakes District ranges among post-glacier lakes of a gutter type. Its characteristic is a strongly corrugated bottom with a depth reaching 55.6 m. in some places and limpid surface water, which deserves special stressing. The examined settlement lies in the southern part of the lake, some 20—30 m. far from the swampy coast. Preliminary geological boring proved that the settlement had been built on a limestone lake shoal. Archaeological and geological examination stated that the shoal was at that time on the level of the water’s mirror (obviously in dependance of its fluctuation). According to information provided by the local population, the part of the lake directly over the discovered settlement does not freeze in winter, or if so, is covered only with a very thin crust of ice, which may be explained by the occurring of springs difficult to seize, starting out of this part of the bottom.

A preliminary geological examination allowed to establish the following stratigraphic system:

0—15 cm. sediment humus with lake chalk admixture
15—25 cm. culture layer containing timber and vegetation remainders as well as various remains
25—350 cm. lake chalk
350—450 cm. chalk gyitia
450—455 cm. humus
455—465 cm. sand with gyitia
465—500 cm. sand with gravel (natural bottom of the lake).

Archaeological research comprised only the culture layer containing constructions, and the upper chalk layer some 50—60 cm. thick.
THE RESULTS OF UNDERWATER EXPLORATION

We owe the discovery of the settlement within the Pilakno lake to Mr. Kulig, forester, who fished out of this part of the lake several whole earthenware vessels in the thirties. Later research was continued by German archaeologists. Lacking adequate equipment they limited their activity to fishing out further vessels, which were then placed in the museum of Königsberg (now Kaliningrad).\textsuperscript{11} Preliminary reconnaissance in 1959 with Polish archaeologists taking part, and in 1960 with the help of skilled divers, brought exceedingly interesting and encouraging results.\textsuperscript{12} A team of archaeologists from the Institute of History of Material Culture of the Polish Academy of Sciences in Warsaw, assisted by two groups of skilled divers, carried out excavation research in 1961—1962.\textsuperscript{13}

The examined area lying under water was covered with reeds growing on a thick layer of "liquid" slime containing vegetation remains. Our research bases were floating piers, 3 by 3 m. large, able to carry over one ton load (fig. 2, point A), and to be immobilized right above the desired spot i.e. the examined dug-out. One of the piers provided with a tent serviced the archaeologists and divers, the other one carried all the heavy equipment, the bottles with compressed air and fire engines. Also wooden boats, small rubber rafts and "dinghys" were used. Our first duty was cutting away the reeds and removing all the rubbish covering the bottom. Uprooting the reeds or tugging at the bare roots proved to be unpractical and harmful science they had often grown right into the old wooden building and beams lying underneath might thus easily be destroyed.

Squares of 25 m.\textsuperscript{2} (5 by 5 m.) were connected to permanent repair spots and marked out along the bottom with a contrasting nylon line. Further clearing consisted in disclosing the system of construction and revealing other mobile and immobile elements by removing the layers of sediment using a strong water current (fig. 2). This was obtained by availing ourselves of the fire engine (B) set on one of the floating piers. In the first stage of our research we tried a method of pumping out the liquid slime. The effect was slow and uneconomical, as the fire engine got continually stopped by plant remainders covering the bottom.

A new method was therefore applied. It consisted in altering the water's circulation i.e., making use of the strong stream of water (3—4 Atm.) spouted by the generator. This was made to run 20—30 cm. above the examined layer (see fig. 2) A diver (I) swimming immediately above the bottom stirred with his hands the water flowing just over the bottom and lifting the slime and all vegetation remnants; this allowed
Fig. 2. Diagram of underwater explorations in the Lake Pilakno.
(Des. A. Tiomakowska)

A: floating pier (molo); B: fire engine; C: rubber pipe supplying water under pressure;
D: manifold distributor; E: water jet made fast to iron scaffolding; F: compressed air
bottles with pressure-regulating governor; G: rubber pipe providing diver with air by the
“narghile” method; H: reducing apparatus; I: diver; K: the archaeologist in his “dinghy”;
L: disclosed wooden structure; direction of water circulation
Fig. 3. Rybno, district Mrągowo. Archaeologists watching the divers’ underwater work from their “dinghies”, (Phot. Z. Bukowski)

Fig. 4. Rybno, district Mrągowo. Underwater draughting of the grate settlement’s wooden structure. Lattice work seen to the right. (Phot. Z. Bukowski)
the diver and the surveying archaeologist to see right through clear water and continue their observations. The size and course of the water stream had to be governed by a complex of 3—5 water-jets of various dimensions, made fast to a heavy iron scaffolding (E) lowered to the bottom. Their permanent fixing was absolutely necessary as the spouting stream caused their vertical (revolving) movement, threatening to destroy the object under observation. The water-jets were set at various angles: perpendicular (upwards) and level (to all sides), so that the slime carried by the stream of water did not settle close by. Underwater works were carried out by a team of divers well equipped with oxygen and then air apparatus. The oxygen apparatus did not prove useful since the activity of oxygen may be noxious to the human organism when used too long. The air apparatus considered to possess better qualities and was applied to divers in two different ways. The first system supplied the diver with an equipment comprising bottles with compressed air, which enabled the diver to remain one to one-and-a-half hour under water. The second, or the so called “narghile” method, supplied air to the diver from big bottles (F) fixed to the floating platform and delivered by a long rubber pipe (G). Setting the air pressure to a level suitable to breathing is effected by a device fixed on top of the bottle and by applying an additional reducing apparatus (H), carried by the diver on his back. His range of activity was naturally limited by the pipe’s length, he could, however, move freely within a space sufficient for observation. This method not only accelerated the rate of investigation, but also saved an amount of compressed air, which could be used directly, instead of having it transferred from big bottles to the small ones, which are part of the diver’s equipment.

Our divers were also outfitted with watertight diving suits made in foam rubber, indispensable to that kind of research in Poland. The temperature of our inland waters is relatively low, reaching even in the summer months no higher than 15—20 °C; this requires a supply of warm clothing to protect the divers from swift exhaustion, due to submarine cold. Our records have proved that a diver without such equipment is able to remain only 15—20 min. under water, repeating his descent several times during the day, whereas the foam rubber overall allows him to work up to two unbroken hours in the deep. The divers’ work was continually watched by archaeologists (K) as follows: one of them kept always immediately above the diver, paddling along in his “dinghy” and was also provided with a diver’s equipment i. e. goggles and “nostrils” (a special pipe device enabling underwater breathing). Thus he could permanently study the diver’s work and interfere when necessary. He possessed even a wider and no worse range
of vision than the diver, although viewed from a different angle (see fig. 3).

As the artificial stream of water carried away all trash and waste, pushing the heavier dregs along the bottom, sometimes far out of the examined space, we had to fix a strong vertical partition of close network at the end of the submarine dugout. We obtained thus an amount of valuable material to botanical research (vegetation remainders, seeds, charcoal etc.). The examined space well cleaned (all roots removed with knives) was covered with a net 1 by 1 m., made in similar nylon thread; thus separate 1 m.², convenient to the carrying out of drawing and photographic documentation were obtained. Every square meter was vertically photographed and the more interesting parts of the building also from a slanting aspect (aslant). Sightglasses of our own construction were used to the purpose of photographing and also a special casing was made in plastic produced in France of the type "Plastiphot-Ocina" L.A.M.E.R. suited to all sorts of cameras. All our relics discovered by exploration were localized in three dimensions.

In order to acquire precis drawings concerning sunken elements of wooden constructions and other details of space disposition we used wooden or metal frameworks 1 by 1 m. large, painted in contrasting colours to make them visible even at a depth of 5—6 m. Their meshes were 10 × 10 cm., also made in contrasting nylon thread. The wooden frames required additional weight to keep them immobilized under water (see fig. 5). Our self-made drawing boards were of "Plexiglass," covered with sheets of celluloid foil, with one tarnished surface suitable to drawing. These were fitted with a net 20 cm. × 20 cm. with 2 by 2 cm. meshes to enable exact drawing in a scale of 1 : 5. Ordinary soft pencils and technical rubbers were used to the underwater job.

Fragmentary plans were later joined to make one total plan. Every settlement layer had to have its particular documentation, which was carried out under water (by the divers possessing a special apparatus — see fig. 4) and then on the floating platforms. In the latter case the drawer (or designer) provided with goggles and nostrils, dipped his head in the water, holding the draft board also under water. This last system proved quicker than the first giving a better and wider range of vision. It is, however, only possible if the objects to be drawn are found at a depth not exceeding 2—3 m. and when the water is relatively clear. Otherwise the image obtained may be deformed or lacking essential details, invisible from that height. The latter drawing method required the divers' help to the setting and shifting of the frames under water and still more if the objects were found rather deep. After removing all wooden parts the settlement layer was explored with the purpose of
Fig. 5. Rybno, district Mrągowo. Setting the latticework underwater. (Phot. S. Biniewski)

Fig. 6. Rybno, district Mrągowo. Fragments of wooden elements discovered underwater. (Phot. S. Biniewski)
extracting the fullest possible relic material generally accumulated underneath. We observed here that single objects and fragments are often sunken deep into the settlement ground, far (i.e. 50—60 cm.) beneath the construction. Not only vessels and grinding stones were found at that depth but also bones and fragments of ceramics.

Our research allowed the collecting of organic samples: the remains of wooden constructions, charcoals, remainders of vegetation (seeds and remnants), also the contents of discovered vessels were mostly organic remainders. Many interesting fragments used to be found within the fencing of framed nets and handed over to botanists.

It seems that the method of exploring used by our group is the best and most economical one in the existing conditions (quaggy bottom) for underwater research. There exists, it is true, another way, i.e. the setting up of a bulkhead or caisson made of four partitions, without bottom or cover and pumping out the water of its inside in order to get a dry ground; however the wood will be immediately destroyed and the calcite slime will make excavation work extremely difficult. Using bulkheads (caissons) such as were lately applied in Denmark to the examination for wrecked ships on the shoal of Roskilde Fjord 14 does not seem promising, as the geological ground, consisting of half liquid slime and deposit layers of loam and limy chalk, will not hold such heavy objects as the walls of a bulkhead, for their weight presses so strongly into the deposit ground, that the whole thing may sink right into it. The sediment layer is sometimes up to 5 m. deep and the ground sometimes so soft that a diver trying to set foot on the bottom, sank knee deep into the slime.

Instead of floating pontoons a pier on pales would certainly be advantageous; it could, however, be reckoned worth while only in the case of a long term research in one place.

Besides investigating a determined section of the settlement, our team achieved a wide penetration of space to establish the settlement's range. The water's transparency naturally helped all underwater observations. These were performed by archaeologists provided with goggles and nostrils, circulating in canoes of "dinghy" type. It may be stated that many fragments of wooden constructions revealed by our research, big pieces of threshing floors and stone hearths were only slightly intergrown by reed roots and were covered with half liquid slime and plant remains. A slight movement of the hand above the object noticed, was enough to have the particular element revealed.

It has been stated that the examined settlement covered an area of 110 by 40 m., which is about 0.5 ha. Wooden constructions occur generally at a depth of 100—120 cm., although we sometimes found them nearer
Fig. 7. Rybno, district Mrągowo. Plan of the first layer of the grate settlement's part disclosed in the Pilakno Lake.
(Des. A. Tłomakowska)

a: wooden beams; b: charcoaled wooden beams; c: pales; d: stones; e: bones; f: clay
the surface or still deeper (up to 2 m.). We never met them quite near
the coast which confirms the suggestion that the settlement was built on
the lake's shoal. The level of the water's mirror at the time of the
settlement's existence has been exactly determined by the remains of
the half-burnt stakes, the sharpened endings of which appear at the
bottom at a similar distance of the actual level of the lake's mirror.

Summing up the results of preliminary research in the Lake Pilakno
we may certainly say that its principal purpose has been attained.
Besides testing and applying some new research methods it has been
proved that this settlement belongs to the type of grate and not pale
settlements (i.e. to the type of settlements put up on grates not on pales)
as had been suggested in scientific literature.\(^\text{15}\) It must have been built
on several superposed layers of beams, thrown on the lake's shoal in
a system difficult to understand. The beams were fixed by stakes driven
vertically or aslant into the bottom. Geological research carried out on
the spot indicated, that the settlement had been founded and persisted
on a very shallow shoal — upon a ground of lake chalk — and did not
reach the lake's coast. Moreover, this part of the lake having underwa-
ter springs, hardly ever froze, or was only covered with so thin a crust
of ice, that it managed to keep its defensive character all the year round.

The discovered quantities of beams, shingles and stones on the area
of 50 m.\(^2\) do not form a shapely construction system, but seem to be
a tumble-down heap (see figs. 6 and 7). A close analysis of this part of
the settlement allows to certify that a grouping of relatively long and
thick shingles (up to 2 m.) and a number of worked beams (fig. 8)
occurred in the middle, whereas in the western part, a number of rough
beams in birch- and alderwood were lying parallel. In the eastern part
we discovered a large stone flat (something like a pavement about
9 sq. m.) and traces of a hearth with remains of charcoal. The above
mentioned three complexes may be read as follows: the accumulated
shingles are probably the remainders of a dwelling or farm building,
may be its floor. From the west was perhaps part of a street or pier
(long beams forming a flat and lying on shorter ones which probably
supported them). The stone flat may have been the remainder of a hus-
bandry building or something else which is now difficult to discern (may
be a bathroom). Underneath this layer occurred another demolished one,
which seems to be the very grate supporting the later built elements of
the settlement. A number of disclosed stakes, driven vertically or aslant
into the foundation are mostly placed disorderly over the space, only
a few of them stand in couples next to one another and between them
are beams and joists strengthening the construction.

The culture layer occurred not above the first construction layer but
underneath it, i.e. over the grate among its wedges and under them.
The culture layer was 15—30 cm. thick. It contained humus (black
mould), vegetation remains, charcoal, fragments of pottery, bones etc.
All these had evidently sunken down from the construction's higher
levels.

Our observations allowed to conjecture that the settlement on the
Pilakno Lake had only short existence (judging by the thin layer of
culture remainders) and was destroyed by fire and then deserted. We
find no traces of reconstruction since a number of beams and shingles
bearing traces of fire lie on top of the wooden construction.

A scarce ceramics material and fragments of a moulding form
belonging to a bronze necklace are able to settle the time of the
settlement's life to about 350—200 before our era, confirmed also by
preliminary geological and palynological research. Owing to the obliging
friendliness of Professor H. Godwyn and Dr E. Willis of the Botany
School in Cambridge (England), we obtained the result of preliminary
examination of a C14 sample of timber taken from the construction
layer. The age of our sample (no Q—709) was determined to reach
230 ± 120 before our era.

In addition to the research described above boring was also effected
within the mentioned settlement in order to establish the stratigraphy
of its geological layers and palynological samples. Through 1.2 m. of
water a Hiller type drill was lowered and samples taken every 5 cm.
right across the sediment 5 m. deep, which gave about 100 samples.
A similar boring was done on a peat ground covering a dried out part
of the lake. The analysis of samples taken from here confirmed our former results.

Palynological research indicated that the culture layers occurred somewhat above the lower limit of the 9th Holocene zone (according to Firbas) and are therefore later than the 5th century before our era. The analysis of vegetation pollens shows a considerable decrease of woodying in the neighboring regions, seemingly more disastrous than the contemporary one; corn pollens reach a maximum representing 11.5% of the whole quantity of pollens collected. We may therefore suppose that there were cultivated fields lying all around the discovered settlement. Another element proving the above are the following pollens occurring here: Plantago lanceolata, Chenopodiceae, Compositae, Artemisia and others. The pollen of leafy trees in relation to needle trees offers a relation 6:4. There is a considerable preponderance of aspen-tree, occurring generally in mixed woods, regenerating after felling. 16

It should moreover be mentioned that besides archaeological research and special works executed in the Pilakno Lake, also excavation has been effected within a mound situated in the neighbourhood of the settlement in question. Preliminary observation (or analysis) of the mound itself as well as of the pottery and burials discovered here, allows to suppose its existence in the early or middle La Tène period. This would agree with the dating of the grate settlement of Pilakno Lake 17.

CONCLUSION

At the close of this article I wish to draw the readers' attention to our complex research. Outside excavation works carried out on the settlement's area and within the mound cemetery, we have also effected geological and palynological research, and specialistic examination of samples of bone, timber and plant remainders. We have obtained preliminary results of C14 method examination and we intend to carry out a research concerning the fluctuation of the Pilakno Lake's surface level throughout the several thousands of past years. We shall continue the research of Pilakno Lake in the years to come.

Further research in other regions of Poland are to be continued hoping for significant results in the Odra's estuary or the Bay of Szczecin (Zalew Szczeciński), the Bay of Gdańsk and the Vistula estuary. The finding of early Middle Age boats linked with the trading centres: Szczecin and Wolin, Truso and Gdańsk — is expected. On the other hand it is to be stressed that Poland offers very difficult conditions for underwater research, especially in her rivers' estuaries and the coastal
line around them. Both the above mentioned rivers may be noted as strongly polluted, owing to great quantities of loam carried right down to their mouths and covering large spaces of neighbouring land. This makes underwater research extremely difficult.

In submarine research vertical and horizontal echo sounders are expected to be very useful. They are already applied in many countries for the navy and also for long distance marine fishing. They are indispensable to research along large spaces of sea coasts and are able to note objects lying at various depths, which may then be subjected to archaeological research.

NOTES

1 The first attempts of such a research had been lately carried out within the German Democratic Republic. Cf. G. Kapitän, Vorläufiger Bericht über die Untersuchungen an der Kemlade im Cambser See, Kr. Schwerin, "Ausgrabungen und Funde", Vol. VI, 1961, No. 4, p. 205—210 and table 30 a-b. In U.S.R.R. underwater explorations are conducted all over the country (Cf. Z. Bukowski, Podwodne badania archeologiczne w ZSRR [Underwater Archaeological Explorations in the Soviet Union] "Z otchłani wieków", Vol. XXVIII, 1962, p. 105 fol. ibidem literature), on the other hand, underwater research has been limited to the northern coast of the Black Sea, particularly to the Olbia region (Cf. [W. D. Blavatskij] V. D. Blavatskij, Podvodnye razvedki v Olbi, "Sovetskaya Arxeologiya" Вып. III, 1962, No. 3, p. 225 fol.).

2 Cf. Z. Rajewski, O przydatności poszukiwań podwodnych w badaniach archeologicznych w Polsce [Submarine Investigations and Archaeological Explorations in Poland], "Wiadomości Archeologiczne", Vol. XXVI, 1959, No. 1—2, p. 44 fol.


4 W. Filipowiaik, Port wczesnośredniowiecznego Wolina [Die frühmittelalterliche Hafen Wolin], "Materiały Zachodnio-Pomorskie", Vol. II, 1956, p. 184 fol. and fig. 1 (map) fig. 2 and 3 (cross sections and maps of the river Dziwna's bottom) and fig. 6 and 7.


6 Rajewski, O przydatności... [Submarine...], p. 47.

7 L. Leciejewicz, W. Łosiński, Badania archeologiczne w Kołobrzegu
14 See the way of effecting underwater measurements and drawings at a considerable depth applied in submarine archaeological research, (E. J. Ryan and G. F. Bass, Underwater Surveying and Draughting — A Technique), "Antiquity", Vol. XXXVI, 1962, p. 252 fol. particularly tables XXXII—XXXV and figures on p. 254 (fig. 1), 256 (fig. 2) and 259 (fig. 5).
16 Cf. e.g. Rossius, op. cit.
17 Exact data of the palynological analysis of the Lake Piłakno with tables and diagrams are printed within the report on the results of exploration effectuated in 1962 (Cf. Z. Bukowski, J. Dąbrowski, M. Dąbrowski, R. Odoj, op. cit.).