B. Berichte, Länderreferate und Einzelreferate.

The Italian and Austrian thalassological researches in the Adriatic Sea.

Report by Prof. L. Marini (Genova).

After the establishment of the Italo-Austrian Commission for the exploration of the Adriatic, which it was already referred about in this Revue (G. Götzinger, Bd. III, Heft 3 und 4 — L. Marini, Bd. IV, Heft 3), the thalassological researches which the Austrians and the Italians had already separately undertaken, were extended, intensified and completed.

The Austrian "Verein zur Förderung der naturwissenschaftlichen Erforschung der Adria" since 1904 at the beginning by the motor-boat *Argo*, afterwards by the yacht *Adria*, had accomplished careful biological (executed by Prof. Cori) and thalassological (by Dr. Merz and Götzinger) researches in the Gulf of Trieste and along the western coast of Istria. Dr. Merz has recently (*Denkschriften der math-naturw. Klasse der K. Akademie der Wissenschaften*, Bd. LXXXVII) published the results of the researches in the Gulf of Trieste and Dr. Götzinger had already drawn up a report about the works executed along the western Istrian coast in the year 1909, putting particularly in evidence (*Jahresbericht des Vereins zur Förderung der naturwissenschaftl. Erforschung der Adria für 1900—10*), the important conditions of the coast-water.

The Italians since the first cruises executed by them, although with preparatory and preliminary purposes, in the first period of existence of the "Comitato talassologico italiano" (Italian thalassological Committee) under the protection of the "Società italiana per il progresso delle Scienze (Italian Society for the advancement of Science) had already at the beginning with a torpedo-boat (1st cruise) and with H. M. S. "*Montebello*" (2^d cruise) and afterwards with H. M. S. "*Ciclope*" (3^d and 4th cruise), extended the researches to the whole Adriatic, in order to study principally the currents of surface and particularly the coastal current by determinations of temperature and salinity in the upper strata.

In consequence of this the Austrians also — after the mutual agreement stipulated in the meeting of May 1910 at Venice, with the object of associating the separate works and to study together the Adriatic — extended their field of researches to the whole Adriatic. The general plane of the work was expounded in the above quoted referate of Dr. Götzinger.

The annexed map demonstrates the transversal lines along which the Italian and Austrian researches are respectively executed during the quarterly periodical cruises. A first simultaneous cruise was executed between the end of February and the beginning of March of this year (1911) by the Austrian *Najade* (25 febr.—7 march) and by the Italian *Ciclope* (26 febr. — 3 march). Dr. Göttinger gave also summary news of this cruise in the Vol. IV, Heft 1—2, of this *Revue*. From the Austrian part, two preliminary reports of the obtained thalassological results were had without delay: a shorter one was published by Prof. A. Grund of University of Prag in the n. 4 of the "*Zeitschrift der Gesellschaft für Erdkunde zu Berlin*", and an ampler one from Prof. Brückner of University of Wien in the n. 4 of the "*Mitteilungen der k. k. geographischen Gesellschaft in Wien*". In the meeting of the Italian thalassological Committee held in Rome on the 15th October during the fourth meeting of the Italian Society for the advancement of Science, prof. De Marchi of Padua University presented as third memoir of the Committee's publications an ample exposition of the physico-chemical results obtained in this fifth Italian cruise, together with those of the four proceeding ones. From these reports it is ascertained that from the initiated researches, although they are still preliminary, important new general knowledges about the physico-chemical conditions of the Adriatic sea, particularly in the winter-season, may be drawn.

Prof. Grund after having exposed the general program of the joined work, and described the scientific equipping of the *Najade* (which equipping is really arranged according to the more recent scientific criteria and with the up-to-date instruments, and adapted in such a manner, as to permit in the shortest time the execution of the simultaneous determination of the conditions of a whole vertical up down to 1000 m and more of depths) gives news of the first recognized results. There are particularly interesting in respect to the development and extension of the coast water. This appears to have an extension not much marked on the eastern part of the Adriatic, and not accompany the coasts according to a closed zone. So the coast water of the Gulf of Drin is not to be found on the southern coast of Dalmatia, but between 41° 30' and 41° 50' lat. N on the high sea; it seems therefore that it takes its way towards west. This eastern coast water, with salinity between 37 to 38‰ enlarges itself more and more towards North and at least covers the surface of Adriatic in her whole breadth. The northern Adriatic presents a pendent to the conditions of the Gulf of Drin; the brackish water of the Po's mouths, was found again not near Ravenna, but on the high sea to 44° 50' lat. N., that it at East of those mouth. With wonderful concordance in the eastern part, to the same breath, by Capo Promontore, both the temperature and the salinity sink with swift skip. Therefore, according to the author, it is to be assumed, that in the Gulf of Venice a closed circulation in contrary sense to the clock's indices takes place. A current of water with salinity from 36 to almost 37‰, becoming feebler and feebler extends itself along the western Istrian coast; whilst westward of it an hem of cold coast water with a breadth from 30 to 50 mg, accompanies the Italian continental platform. But near Ortona the coast water on the Italian part has not a breadth larger than 10 mg. Also the coast

water of the Gulf of Venice does not seem to take its way towards South along the coasts. Mr. Grund then retains that the general law of the movement of the Adriatic waters, towards North in the eastern part, towards South in the western part, is confirmed, but that it results complicated. In fact from the one and the other current respectively towards West and towards East, branches derive, of which there would be signs, besides the above mentioned ones, also at West of Parenzo and at South of Ponto Planca, and then East of Ascoli towards the depth of Pomo's basin and North of Tremiti isles. In vertical direction it was recognized that the vertical convection dominates principally in the stratification of the waters. The largest differences in the physical properties were found in the northern part, where the convection joining itself together with currents passes to lateral advection. In fact in the eastern part warmer water with higher salinity pushes itself from south under the one sank in place by convection, whilst in the western part colder water penetrates from North in the section. In the Pomo's basin the vertical convection at the time of the cruise had reached only the depths of 100 to 500 m., under which, water with greater salinity and lower temperature than the one of convection, was found. The origin of this bottom water is demonstrated also by the lack of oxygen; probably it was in those places since the last winter. In the greatest depths of the southern Adriatic, on the contrary, the vertical convection had penetrated to the bottom and so the water even at 1000 m. was well aerated.

Prof. Brückner also describes beforehand the equipping of the ship, the organization of the work, the followed route, the observations made during the voyage, and passes then to resume the principal scientific results obtained. He remarks, before all, that the route was directed so as to pass near the region in which the charts sign the maximal depths of the Adriatic, in order to verify the datum of F. von Hopfgartner who in June 1877 on the ship *Pelagosa* at $41^{\circ} 16' 30''$ lat. N and $18^{\circ} 13' 20''$ long. E. Green., is said to have found a depth 1645 m. But the *Najade*, having executed five soundings in those parts did not reach depths greater than 1092 m., whilst in a point very near to the one of Hopfgartner, at 3 km. towards ESE from it, was sounded 1088 m.; and in another distant less than 4 km. towards SE, 1081 m. Therefore there is reason to doubt of the exactness of the ancient datum, or to believe that the deepest area in Adriatic is very limited. This will be verified in the future cruises. Passing to discussion of the physico-chemical data Prof. Brückner puts in evidence, beforehand the fact, that the temperature on the surface presents certainly an increase from North towards South. This is shown in a manner particularly clear proceeding along the central axis of the Adriatic. The lowest temperatures were observed near the mouths of the river Po and of the Venetian coast rivers, to the waters of which principally they are certainly due. In comparison to the air's temperature, the temperature of the surface of the sea in 199 observations resulted higher and in 36 lower. The salinity demonstrated a proceeding parallel to which of the temperature: it was greater in the centre than by the coasts, smaller towards the delta of the Po. The observations of temperature at depths show almost everywhere general conditions of homothermie along every vertical. But it is worth noting the fact that procee-

ding from South towards North, the minimum of every vertical is always higher than the maximum in the next vertical, so that along a longitudinal section of the Adriatic, the isothermal lines should be designed vertical. This demonstrates that every column of water is in a certain way independent from the next one, and has, for its account, in the place, acquired by convection, its thermicity, which would exclude whatever current. The salinity then agrees with the temperature so as notwithstanding the great diversity of this in horizontal sense, the whole water mass of the Adriatic has everywhere the same density. According to Prof. Brückner no sign would be recognized of the presupposed current which formed by warm and with high salinity Mediterranean waters, is paid to direct itself towards North along the Dalmatian coast, and constituted by colder waters with lower salinity, to descend towards South along the Italian coast. Only some afflux of fresh submarine waters (Gargano) and rivers (Po and Venetian rivers) would be manifest. So according to Prof. Brückner the Adriatic waters in winter form, with only insignificant exception, a great mass of still waters, in which currents produced either by physico-chemical inequalities or by winds, are absolutely wanted. The vertical motions of convection lead on the contrary to a homothermy and homosality in the whole mass.

The memoir of Prof. De Marchi is furnished with all the numerical data of the measurements of the temperature and salinity executed, and is rich of numerous diagrams showing the proceeding of their elements along vertical transversal and longitudinal sections. Referring itself to the five first Italian cruises, which are distributed in different seasons of the year (the 1st cruise from 18th August to the 7th Sept, 1909; the 2^d from 17th to 20th Nov. 1909; the 3^d from 20th May to 4th June 1910; the 4th from 8th to 13th Dec. 1910; the 5th from 26th Febr. to 3^d March 1911) and profiting also of the data given in the preceding Austrian relations, it reaches conclusions still more interesting and complete, although still preliminary.

At the end of the summer (1909, 1st cruise) a very sharp layer of skip was found in all the sections, at a depth varying from 10 to 20 m, whilst the sur face layeroverlying, was almost perfectly homothermic. Under this skip layer the temperature continued to diminish with the increasing of the depth, but much more slowly.

At the end of autumn (1909, 2^d cruise) in the superior layers a condition very similar to the homothermy was found, whilst the few observations made at greater depths (100 and 250 m) would demonstrate anathermy. In the high Adriatic however a sharp catathermic condition seems to have been recognized, as a layer of water relatively very cold extends itself over a much more warm one lying on the botton. A sign of catathermy in the surface layers would have been recognized also along the whole Italian coast as far as Brindisi.

At the end of the spring (1910, 3^d cruise) in all the sections anathermic condition was established. The isothermic lines in every section had a proceeding almost horizontal.

At the beginning of the winter (1910, 4th cruise) in the surface layers a catathermy more accentuated was met. It extended on all the sections more than in nov. 1909, not withstanding that the temperature was some

degrees lower in all the depth, down to 30 m. Such conditions depended certainly on the great afflux of river's waters in correspondence with a preceding period of rain.

The observations of temperature at the end of winter (1910—11, 5th Italian cruize, simultaneous to the Austrian one) confirm the vertical homothermy in all the sections, deducted from the Austrian measurements. There are to be excepted the regions near the coast, where a mass of colder water extends itself over the warmer deep water, at Malamocco, or adheres to the coast itself as at Ancona, Bari, Otranto. The distribution of the temperature at the end of winter 1910—11 as it results from the Italian and Austrian observations is represented by prof. De Marchi by the proceeding of the isothermal lines reproduced in the annexed chart. On the basis of the observed conditions, prof. De Marchi thinks, in accordance with Brückner's views, that the thermal variations in the Adriatic take place in the following way. During the winter a vertical homothermie which may reach the maximal depths, establishes itself, owing to the exchange by convection, produced by the prolonged superficial cooling. By the first warming of the season an anathermic condition establishes itself for the warming of the surface layers, which conditions we find in spring and is contradistinguished by a strong thermic gradient in the upper strata, which attenuates itself with the increasing depth. By the continuation and the increasing of the warming, in summer a superficial evaporation growing continually accompanies itself to it, by effect of which the concentration of the salts increases and so a motion of convection by the increasing of density in the surface begins. Owing to the motion of convection the temperature equales itself in a superficial stratum thicker and thicker, and, as the superficial warmer water in the underlying layer sinks at a certain depth, an anathermic stratum of skip determines itself underneath. When the autumnal cooling begins, the convection by superficial cooling substitutes itself, to the convection by concentration and by it the surface layer maintains itself homothermic but progressively gets cold. By this cooling from the high the skip's layer is cancelled, and afterwards the homothermy propagates itself in depth, and it may extend itself down to the bottom as winter goes on. This regular succession of phenomena may be complicated by other accessory phenomena, the most important of which is the diffusing in surface of varying mass of fresher water, which may be colder without sinking. Then a catathermic distribution takes place in the upper strata, whilst the underlying layers keep themselves warmer than the upper ones, and it is characteristic condition of the northern Adriatic and frequent along the whole coast. In deeper sea, under a certain depth, the anathermic distribution may maintain itself, and we find also in the whole depth a warmer stratum between two colder ones (mesothermy).

From the determinations of salinity (which however were executed only in the last three cruises) prof. De Marchi has reason to believe that: a) at the end of spring (3^d cruise) a progressive increasing of salinity with the depth reveals itself, and it is the more accentuated as the more the station is towards North. In the two northern transversal sections a surface layer sensibly fresher with a thickness of few meters sharply separates itself; and

it is notable that the detachment is more sharp at Ancona than at Malamocco. The salinity in all the sections and at all the depth down to 30 m. is greater than in two winter seasons. — b) At the beginning of winter (4th cruise) there is still a progressive increasing of the salinity with the depth, but not so regular, whilst the formation of layers with equal salinity begins, except in the shallow waters at Malamocco. The superficial layer with exceptionally low salinity is found again by Ancona. The salinity is in all the depths, excepting also only Malamocco, less than in the preceeding and following cruise. — c) At the end of winter (5th cruise) we are very near to the conditions of vertical homosalinity, which however are not, as it is natural, immediately near the coasts and in the superficial layers so absolute as at the large, and in the deepest strata. Particularly by Malamocco a superficial stratum not so salted persists. The salinity in all the sections and in all the depths results increased since the preceeding December.

The author makes then remarked particularly the characteristical fact that would result from the longitudinal profils of the three last cruises; that is the presence in the southern extremity of the Adriatic basin of a promontory or of a column with higher salinity, which elevates itself from the deepest strata up to the surface or a little under it, and which limits at south a mass of water with lower salinity, which occupies the southern Adriatic in the upper strata. In the 3^d and 5th cruise this mass not so salted is warmer, in the 4th colder. Another band not so salted and colder is cut by the vertical profils of the 2^d and 4th cruise in the middle of the Adriatic by Ancona. It extends itself probably towards North as far as the mouths of the river Po, to the waters of which it should have its origin.

From the above mentioned conditions Prof. De Marchi does not deduce however, for the winter season, an absolute want of movements in the superficial waters as Prof. Brückner believes; De Marchi on the contrary, particularly on the basis of the preceeding of the superficial isothermal lines, demonstrated in the map, believes in the existence of a motion of transport from South towards North at any distance of the Dalmatic coast, and in a movement from North towards South along the western side. The colder water which also goes down along the Italian coast should be deviated by the spar of Gargano towards the high sea, justifying the cold wedge which pushes itself towards SE, and which seems to determine the insinuating of the warm wedge in the Gulf of Manfredonia. Then the barrier observed along the Otranto channel would lead us to exclude that the warm ascending current proceeds from the Ionian sea; also that the cold descending one has its issue in this sea. We may therefore have the ideas of a superficial circulation closed into the Adriatic. A proof of this proceeding of currents should be the finding of some swinging bottles thrown appositely by Dr. Feruglio geophysical assistant of the thalassological Italian Committee.

Signs of the real existence of current either localized, or extended at a less or a more long spaces of coast are recognized by De Marchi in the anomalies in respect to the general characteristical conditions of stratification of temperature and of salinity on the different seasons, demonstrated by the observations even of the first four cruises. The author mentions some of these anomalies, but particularly puts in evidence the following ones: a) a

warm and more salted band near the Albanian coast (2^d, 3^d, 4th, 5th cruises); b) a band warmer and colder, according to the season, with higher salinity, some miles from the coast, on the section of Malamocco (3^d, 4th, 5th cruises); c) one or more colder bands, with lower salinity, at variable distance from the coast, in the section of Ancona. These observations well agree with the data referred by Grund. According to De Marchi, the first of those irregular bands would be the origin of the warm ascending current, the second would represent a current going down, deriving from the Istrian coasts where the water has a higher salinity; whilst the frisher bands in the section of Ancona should represent the going down of the water of the rivers Po, Adige and those ones of the Romagna.

As it may be acknowledged, the data referred by the different authors for the Italian and Austrian cruises well agree between them and even the results deducted by the same authors meet themselves in the general fundamental lines, bringing a notable important contribution to the knowledge of the physico-chemical conditions of the Adriatic water. The discordance with regard to some particular views will readily disappear when more numerous and complete data will be collected in the future cruises.