angular fins, each rising 5 to 6 feet above the water, while the second view showed a large round head 6 feet in diameter, with huge flappers, which moved like those of a turtle.[1] It would thus appear that, while, with very few exceptions, all the so-called "sea-serpents" can be explained by reference to some well-known animal or other natural object, there is still a residuum sufficient to prevent modern zoologists from denying the possibility that some such creature may after all exist.

Quite distinct in origin from the stories already touched on is the legend of the sea-serpent or *tinnín* among the Arabs (Mas'údí, i. 266 *sq.*; Kazwíní, i. 132 *sq.*; Damiri, i. 186 *sq.*), which is described in such a way as to leave no doubt that the waterspout is the phenomenon on which the fable rests. The *tinnín* is the Hebrew *tannín* (E.V. "whale," "dragon"), which in Ps. cxlviii. 7 might in the context be appropriately rendered "waterspout."

In addition to the sources already cited, the reader may consult *Blackwood's Magazine*, vol. iii., 1818; Lee, *Sea Monsters Unmasked* (International Fisheries Exhibition *Handbook*), London, 1883; Cogswell. *Zoologist*, pp. 1841, 1911 (1847); and Hoyle, *Proc. Roy. Phys. Soc. Edin.*, vol. ix. (W. E. HO.)

SEA-SICKNESS, a peculiar set of symptoms experienced by many persons when subjected to the pitching and rolling motion of a vessel at sea, of which depression, giddiness, nausea, and vomiting are the most prominent.

Although the vast majority of persons appear to be liable to this ailment on exposure to its exciting cause (the instances of complete and constant immunity being rare), they do not all suffer alike. Many endure distress of a most acute and even alarming kind, while others are simply conscious of transient feelings of nausea and discomfort. In long voyages, while many are affected with sea-sickness for the first few days only, others are tormented with it during the entire period, especially on the occurrence of rough weather. In short voyages, such as across the English Channel, not a few even of those susceptible escape, while others suffer in an extreme degree, the sickness persisting long after arrival on shore.

The symptoms generally show themselves soon after the vessel has begun to roll by the onset of giddiness and discomfort in the head, together with a sense of nausea and sinking at the stomach, which soon develops into intense sickness and vomiting. At first the contents of the stomach only are ejected; but thereafter bilious matter, and occasionally even blood, are brought up by the violence of the retching. The vomiting is liable to exacerbations according to the amount of oscillation of the ship; but seasons of rest, sometimes admitting of sleep, occasionally intervene. Along with the sickness there is great physical prostration, as shown in the pallor of the skin, cold sweats, and feeble pulse, accompanied with mental depression and wretchedness. In almost all instances the attack has a favourable termination, and it is extremely rare that serious results arise, except in the case of persons weakened by other diseases, although occasionally the symptoms are for a time sufficiently alarming.

The causes giving rise to sea-sickness have long been discussed, and a vast number of theories have been proposed. The conditions concerned in the production of the malady are apparently of complex character, embracing more than one set of causes. In the first place, the rolling or heaving of the vessel disturbs that feeling of the relation of the body to surrounding objects upon which our sense of security rests. The nervous system being thus subjected to a succession of shocks or surprises fails to effect the necessary adjustments for equilibrium. Giddiness and with it nausea and vomiting follow, aided probably by the profound vaso-motor disturbance which produces such manifest depression of the circulation. Much has been made by some of the effects of the displacement of the abdominal viscera, especially the stomach, by the rolling of the vessel; but, while this may possibly operate to some extent, it can only be as an accessory cause. The same may be said of the influence of the changing impressions made upon the vision, which has been regarded by some as so powerful in the matter, since attacks of sea-sickness occur also in the dark, and in the case of blind persons. Other contributory causes may be mentioned, such as the feeling that sickness is certain to come, which may bring on the attack in some persons even before the vessel has begun to move; the sense of the body being in a liquid or yielding medium as it descends with the vessel into the trough of the sea, the varied odours to be met with on board ship, and circumstances of a like nature tend also to precipitate or aggravate an attack. Dr Chapman's view is that the essential cause is an undue afflux of blood to the spinal cord. But, in the few rare instances where sea-sickness has proved fatal, *post-mortem* appearances have been almost entirely negative, and only such as are met with in death from syncope.

Innumerable preventives and remedies have been proposed; but most of them fall far short of the success claimed for them. No means has yet been discovered which can altogether prevent the occurrence of sea-sickness, nor is it likely any will be found, since it is largely due to the pitching movements of the vessel, which cannot be averted. Swinging couches or chambers have not proved of any practical utility. No doubt there is less risk of sickness in a large and well-ballasted vessel than in a small one; but, even though the rolling may be considerably modified, the ascending and descending movements which so readily produce nausea continue. None of the medicinal agents proposed possess infallible properties: a remedy which suits one person will often wholly fail with another. There appears to be a wide concurrence of opinion that nerve sedatives are among the most potent drugs which can be employed; and full medicinal doses of bromide of potassium, chloral, or opium (the last two only under strict medical direction) taken before sailing appear to act usefully in the case of many persons. On the other hand, some high authorities have recommended the employment of nerve stimulants, such as a small cupful of very strong coffee to be taken about two hours before sailing, which will frequently prevent or mitigate the sickness. When the vessel is in motion, or even before starting, the recumbent position with the head low and the eyes closed should be assumed by those at all likely to suffer, and, should the weather admit, on deck rather than below,—the body, especially the extremities, being well covered. Many persons, however, find comfort and relief from lying down in their berths with a hot bottle to the feet, by which means sleep may be obtained, and with it a temporary abatement of the distressing giddiness and nausea. Should sickness supervene small quantities of some light food, such as thin arrowroot, gruel, or soup, ought to be swallowed if possible, in order to lessen the sense of exhaustion, which is often extreme. The vomiting may be mitigated by saline effervescing drinks, ice, chloroform, hydrocyanic acid, or opium. Alcohol, although occasionally useful in great prostration, is not generally found to be of much service, but tends rather to aggravate the sickness. Dr Chapman, in accordance with his view of the cause of the sickness, introduced a spinal ice-bag, which has been extensively employed and recommended; but, like every other plan of treatment, it has only occasional success. The more recently proposed remedies, such as nitrite of amyl and cucaine, do not seem to yield any better results than the agents already mentioned.

SEATTLE, county seat of King county, Washington Territory, United States, on Seattle Bay, east side of Puget Sound, with Lake Union, 3 miles long, on the north, and Lake Washington, 25 miles long, on the east, is the largest city of the Territory. A ship canal to connect these lakes with Puget Sound is now (1886) in course of construction. Seattle has shipyards, foundries, machine-shops, sawmills, lumber-yards, breweries, and manufactories of furniture, carriages, cigars, crackers, patent medicines, boxes, and barrels. It possesses the Territorial university. The Columbia and Puget Sound and the Puget Sound Shore Railroads have their terminus here, whence large shipments of coal take place. The population in 1880 was 3533, and in 1885 it was estimated at 12,000.

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[1] Dr Andrew Wilson has claimed this monster as a ribbon-fish, *Times*, 15th June 1877.

SEA WATER.[1] The ocean covers very nearly eight-elevenths of the total area of the globe; its average depth may be estimated as 2000 fathoms, and its total mass at $1·322 \times 10^{18}$ (*i.e.*, 1·3 million million millions) tons. Its general configuration must be assumed to have been substantially the same as it is now for thousands of years; hence we may safely conclude that the absolute composition of the ocean as a whole is constant in the sense of being only subject to very slow progressive millennial variation, and that, taking one part of the ocean with another, the percentage composition of the fixed part of the *solutum* can oscillate only within narrow limits. The composition of this solutum is very complex. According to Forchhammer, ocean salt in addition to the chlorides and sulphates of sodium, magnesium, potassium, and calcium—which had long been known to be its principal components—includes silica, boric acid, bromine, iodine, fluorine as acid, and the oxides of nickel, cobalt, manganese, aluminium, zinc, silver, lead, copper, barium, and strontium as basic components. Arsenic, gold, lithium, rubidium, cæsium have been discovered since Forchhammer wrote. But all these subsidiary components, as that investigator found, amount to very little,—so little that in his numerous quantitative analyses of waters which he had procured from all quarters of the globe he confined himself to the determination of the chlorine, sulphuric acid, magnesia, lime, potash, and soda. The soda, however, he determined only by difference, assuming that the muriatic and sulphuric acids are united with the bases into perfectly neutral salts. As a general result he found that, in the open ocean, the ratio to one another of the several acids and bases named is subject to only slight variations. But his samples had all been collected at the surface; the potash had been determined by an insufficiently exact method; and the assumed neutrality of the total salt had not been proved. With the view primarily of supplementing Forchhammer's work, Dittmar made complete analyses of 77 of the samples brought home by the "Challenger," so selected that 34 out of the 77 represented depths of 1000 fathoms or more. His analyses brought out a small surplus of base, proving the presence of carbonate in all the waters; but the numerical values thus found for the "alkalinity," being charged with the observational errors of the whole series of determinations, could not be relied on. Dittmar therefore subsequently availed himself of a very easy and yet exact method for the direct determination of this quantity, which meanwhile had been discovered by Tornöe, and applied it to over 130 "Challenger" samples. He besides made a special inquiry into the relation between the quantity of lime and the depth at which the water had been collected, and a similar inquiry in regard to the bromine. As a general summary he gives the following three tables. The total salts contained in ocean water amount on an average to about 3·5 per cent., thus leaving 96·5 per cent. for the water proper.

TABLE I.—*Average Composition of Ocean-Water Salts.*

	Per 100 parts of Total Salts.	Per 100 of Halogen calculated as Chlorine.	
	Dittmar.	Dittmar.	Forchhammer.
Chlorine............ ...	55·292 ⎫	99·848	Not determined.
Bromine..................	0·188 ⎭[2]	0·340	Not determined.
Sulphuric acid, SO_3	6·410	11·576	11·88
Carbonic acid[3], CO_2	0·152	0·274	Not determined.
Lime, CaO...............	1·676	3·026	2·93
Magnesia, MgO........	6·209	11·212	11·03
Potash, K_2O	1·332	2·405	1·93
Soda, Na_2O	41·234	74·462	Not determined.
(Basic oxygen, equivalent to the halogens)	(−12·493)	(−22·559)	......
Total salts......	100·000	180·584	181·1

TABLE II.—*Results from combining Acids and Bases* (Dittmar).

Chloride of sodium.........	77·758	Sulphate of potash	2·465
Chloride of magnesium ...	10·878	Bromide of magnesium	0·217
Sulphate of magnesium ...	4·737	Carbonate of lime	0·345
Sulphate of lime...........	3·600	Total salts...	100·000

Reducing to the absolute mass of the ocean as given above, we arrive at the following numbers:—

TABLE III.—*Absolute Composition of the Salts of the Ocean.*

Unit = 1 million million = 10^{12} tons.

Chloride of sodium	35990	Sulphate of potash	1141
Chloride of magnesium ...	5034	Bromide of magnesium ...	100
Sulphate of magnesium ...	2192	Carbonate of lime............	166
Sulphate of lime	1666		46283

Total bromine ....87·2 (Dittmar).
Total iodine .... 0·03 (Köttstorfer).
Total chloride of rubidium ....25·0 (C. Schmidt).

Of the several quantities recorded in columns 2 or 3 of Table I. "carbonic acid" is proved to be subject to variation; all the rest, including even the bromine, are practically constant. This shows that Forchhammer's proposition holds for ocean water from all depths, with one important qualification: special research on the lime showed that its quantity increases slightly but appreciably with the depth. Taking s, m, d as representing the lime per 100 of chlorine in shallow, medium-depth, and deep-sea water respectively, Dittmar found as mean results of analyses which agreed very well together—

$$\begin{array}{lccc} & s=3·0175 & m=3·0300 & d=3·0308 \\ \text{Probable error,} & \pm0·0012 & \pm0·0014 & \pm0·0011. \end{array}$$

But $m-s=0·0124$ and $d-s=0·0132$. One explanation of this result is that the crustaceans, foraminifera, and molluscs which form carbonate of lime shells live chiefly in surface waters, but after their death sink to the bottom, where—especially in great depths—their carbonate of lime is partially redissolved.

Oceanic Carbonic Acid.—It is well known that not only in the neighbourhood of actual volcanoes but in thousands of other places on the dry land carbonic acid gas is constantly streaming forth into the atmosphere, and it is generally admitted now that this supply of telluric carbonic acid amounts to more than all that is furnished by processes of combustion and respiration. That carbonic acid springs should be absent from the bottom of the ocean is too absurd an assumption to be entertained; hence, supposing even the water of the ocean were perfectly neutral, it could not but contain dissolved carbonic acid. But such carbonic acid, at the ocean surface at least, would constantly tend to assume, and in general probably actually would come down to, the small limit value prescribed to it by the given proportion by volume of the carbonic acid in the atmosphere and the laws of gas-absorption. This proportion, according to the best modern researches, is almost constant, everywhere amounting to very nearly 0·0003 volume per unit volume of air. The coefficient of absorption by even pure water is 1·8 at 0° and 1·0 at 15° C. Hence, even in the polar regions, the surface water could not hold in permanent solution more than about 0·54 c.c., or say one milligramme per litre of water. Jacobsen, in his

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[1] All our knowledge of the subject of chemical oceanography—a branch of physical geography which has only lately come to be extensively cultivated—is derived from a series of investigations chiefly embodied in the following publications:—(1) Forchhammer, "On the Composition of Sea Water," &c., in *Phil. Trans.*, i. 155, pp. 203-262 (1865); (2) Oscar Jacobsen, *Ann. d. Chem.*, vol. clxvii. p. 1 *sq.* (1873); (3) *Den Norske Nordhavs Expedition, 1876-78: Chemi*, by Tornöe); (4) the *Jahresberichte* of the Kiel committee for the scientific investigation of the German Ocean, 1873-82; (5) *Physics and Chemistry of the Voyage of H.M.S. "Challenger"*—I. "Report on Researches into the Composition of Ocean Water," &c., by Prof. W. Dittmar, January 1884; II. "Report on the Specific Gravity of samples of Ocean Water," &c., by J. Y. Buchanan, January 1884; III. "Report on Deep-sea Temperature," &c., by the officers of the expedition. A shorter and more popular exposition of the whole is found in—(6) *Narrative of the Cruise of H.M.S. "Challenger"* (1885). The excellent *Handbuch der Oceanographie* (Stuttgart), by Prof. G. von Boguslawski, may be referred to as being almost up to date.

[2] Equal conjointly to 55·376 parts of chlorine, which accordingly is the percentage of "halogen reckoned as chlorine" in the real total solids.

[3] Calculating the surplus base as normal carbonate. In Table II. this carbonate is represented as so much $CaOCO_2$.

numerous analyses of North Sea water, found from 90 to 100 milligrammes per litre; but he also observed that only a small portion of the carbonic acid is eliminated on boiling: the rest comes out only when the water is distilled to dryness. He presumed that the gas was retained chemically by the chloride of magnesium. Buchanan, who inquired into the subject synthetically, arrived at the conclusion that it was the sulphates[1] in sea water (*qua* sulphates) which retained the carbonic acid. Accordingly in his numerous carbonic acid determinations he liberated the gas by distilling the water down with an excess of chloride of barium. Tornöe was the first to prove that the carbonic acid in sea water is present as carbonate, and that, in the northern part of the North Atlantic at least, the total carbonic acid, while considerably greater than the quantity which would convert the surplus base into normal, falls short of that which would be required to produce fully saturated acid carbonate.

Even without Tornöe's discovery it would have been necessary to find the true interpretation of the results of the numerous carbonic acid determinations made during the voyage of the "Challenger" by Buchanan. Dittmar had no difficulty in proving the non-existence of the alleged affinity of sulphates for carbonic acid, and naturally concluded that the chloride of barium used in the processes liberates the *loose* part of the carbonic acid by converting the normal carbonate part into a precipitate of carbonate of baryta, thus—$R''CO_3 + xCO_2 + BaCl_2 = R''Cl_2 + BaCO_3 + xCO_2$. A series of synthetical experiments showed that this is substantially, though not exactly, correct. If Buchanan's *modus operandi* be rigorously followed, the carbonic acid obtained, as a rule, falls somewhat short of the actual amount of loose carbonic acid present, while on resuming the distillation after addition of fresh water an appreciable part of fixed carbonic acid passes away as gas. Yet, Buchanan's results being of great value, Dittmar discussed them (conjointly with his own alkalinity determinations) on the basis of the assumption that they afforded a fair approximation to the proportions of loose carbonic acid in the respective waters. His general conclusions are as follows. Taking "alkalinity" as meaning the "weight" of the carbonic acid, CO_2, in the normal carbonate part of the carbonate present per 100 parts of total solids, the alkalinity in the water samples analysed (omitting a few obviously abnormal cases) was found to be as follows (Table IV.):—

Alkalinity ranges from	Number of Cases.	Alkalinity ranges from	Number of Cases.
0·1400 to 0·1439	9	0·1640 to 0·1719	6
0·1440 ,, 0·1479	34	Alk. = 0·1731	1
0·1480 ,, 0·1519	40	,, = 0·1888	1
0·1520 ,, 0·1559	19	,, = 0·2079	1
0·1560 ,, 0·1599	12		
0·1600 ,, 0·1639	4	0·1400 to 0·2079	127

Values above 0·16 are obviously exceptional; hence the normal range may be said to be from 0·14 to 0·16. The most frequently occurring values were found to be about 0·146 in the case of surface or shallow sea water, and in the case of bottom water about 0·152. In regard to the loose carbonic acid a full discussion of Buchanan's results led to the following conclusions:—(1) carbonic acid rarely occurs in the free state; as a rule it falls short of the quantity which would produce bicarbonate; (2) in surface waters it is relatively high where the natural temperature is relatively low, and *vice versa*; (3) within equal ranges of temperature it seems to be less in the surface water of the Pacific than it is in that of the Atlantic Ocean. Of the 195 samples of sea water which Buchanan analysed for carbonic acid only 22 contained fully saturated bicarbonate, and only 2 out of these are proved by the analyses to have contained free carbonic acid in addition to bicarbonate. In all the remaining 173 samples the "carbonic acid deficit" (meaning the proportion of carbonic acid which was wanted to completely transform the carbonate into bicarbonate) assumed tangible and often considerable values. We are probably safe in concluding that the ocean as a whole will have to continue taking in carbonic acid for thousands of years before its carbonic acid deficit has been reduced to nothing. But it is as well to observe that at its surface in the warmer latitudes the attainment of this condition is a physical impossibility as long as the percentage of carbonic acid in the air retains its present low value.

A solution of a bicarbonate when shaken, say in a bottle, with pure air (free of carbonic acid) at summer heat gives up its combined carbonic acid to the air space in the bottle until the partial tension of the acid gas there has come up to a limit value p, which is called the dissociation tension of the bicarbonate at the prevailing temperature t. General experience concerning such phenomena warrants the presumption that, up to a certain (low) temperature t_0, $p=0$, and thence onwards, p increases with t. It does not follow that the bicarbonate in a solution when shaken again and again with even pure air tends to become normal carbonate; for aught we know, the elimination of carbonic acid may stop as soon as the residual carbonate has come down to some composition $R''O(1+x)CO_2$ (where x is less than 1), and x may be a function of temperature. Dittmar has attempted to determine the course of the function $1+x=f(t)$ in reference to natural sea water on the one hand and to pure air (air freed of its carbonic acid) and ordinary air on the other. One sample of sea water containing its surplus base as practically bicarbonate served for all the experiments. It was shaken again and again at a fixed temperature t with one or the other kind of air, until (after "N" shakings, always with renewed air) the stage of saturation appeared to have become constant. The investigation is not completed yet; the following table (V.) gives the results which have come out so far. The final carbonate was $R_2O.nCO_2$.

t.	N.	Pure air. n_0.	Ordinary air. n_1.	t.	N.	Pure air. n_0.	Ordinary air. n_1.
2° C.	200	1·90	..	15°	200	1·50	..
2°	200	2·04	..	20°	200	1·42 (?)	..
2°	52	..	2·06	25°	52	1·53	..
10°	200	1·70	..	32°	52	1·53	..
13°	50	..	1·841	32°	52	..	1·89
15°	100	1·63	..	32°	150	..	1·82

Hence we see that even at the highest temperature, and with air free from carbonic acid, the carbonate never came down below the state of sesquicarbonate, while with ordinary air, even at 32° C., it never fell below $n=1·8$. At 2° n_0 as well as n_1 was $=2$, the value characteristic of bicarbonate. Now Buchanan reports a good number of cases where, even at lower temperatures, n was considerably less than 1·8 at any rate. Hence, if his numbers are correct, unless the atmosphere acts more powerfully than the air in Dittmar's bottle, it would appear that deep-sea water is in general below even the stage of carbonic acid saturation which it could attain at the surface at high temperatures.

In any mixed solution of salts every base is combined with every acid; hence the "carbonate" of sea water is strictly speaking a complex plural. But as a matter of probability the carbonic acid has very little chance of uniting with any of the potash or soda, and the overwhelmingly large quantity of alkaline chloride would no doubt convert any carbonate of magnesia that was introduced into double chloride of magnesium and alkali metal; hence it is fair to assume that oceanic carbonate is chiefly carbonate of lime. Now immense quantities of this compound are being constantly introduced into the ocean by rivers. Dumas once gave it as his opinion that this imported carbonate remains dissolved in the ocean as long as and wherever the carbonate there is at the bicarbonate stage; but, as soon as part of the loose carbonic acid goes off into the air, the corresponding weight of normal carbonate separates out as an addition, ultimately, to the solids on the bottom. Dittmar has tried to test this notion synthetically, but without arriving at very definite results. According to his experiments sea water which contains free carbonic acid dissolves added solid carbonate of lime, and more largely carbonate of magnesia; sea water which contains fully, or almost fully, saturated bicarbonate dissolves carbonate of magnesia very appreciably, but would not appear to act on carbonate of lime at all. But, when carbonate of lime was produced in the water by successive additions of potential calcium carbonate in the form of dissolved sodium carbonate and its equivalent of calcium chloride, the original carbonate of lime could be increased very largely, with formation of solutions which remained clear during a long-continued period of observation. As a set-off against this a few of the many hundred samples of sea water which he received from the "Challenger" deposited in the course of a number of years crystalline crusts of carbonate of lime on the sides of the bottles; and the mother-liquor never contained more than the normal quantity of lime per 100 parts of chlorine. In discussing this question Dittmar gives an estimate, based on data furnished by Boguslawski's work, of the total carbonate of lime introduced into the ocean annually by the thirteen principal rivers; and by doubling the quantity he estimates the carbonate of lime introduced by all rivers as equal to about $1·34 \times 10^9$ tons. Now the sum total of carbonate of lime, $CaCO_3$, in the ocean amounts to about 160×10^{12} tons; hence it would take 1190 years to increase the present stock of carbonate of lime in the ocean by one per cent. of its value.

Absorbed Oxygen and Nitrogen in Ocean Water.—As a matter of physical necessity these two gases must be present in the water of the ocean—and they may be presumed in general to pervade it to its greatest depth—because the whole of the surface of the sea is in constant contact with the atmosphere. Our knowledge regarding their distribution in the ocean may be said to date from 1872, when Jacobsen inquired into the matter in a most masterly manner in connexion with the German North Sea expedition. The work of his predecessors possesses no scientific value, because they employed inadequate methods. Unlike them, Jacobsen did not attempt to analyse a sample of sea water air on board ship: he extracted the air from measured samples (by an excellent method of his own) and then sealed them up in glass tubes, to measure and analyse them after his return home. Buchanan, during the

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[1] See GEOLOGY, vol. x. p. 222.

"Challenger" cruise adopted Jacobsen's method. Of the 164 samples which he sealed up successfully 69 came from the surface and 95 from depths varying from 5 to 4575 fathoms. A good number of these he analysed himself after his return; the majority, however, were analysed and all were measured by Dittmar. The latter, in order to be able to interpret the results, also investigated the absorption of oxygen and nitrogen gas from air by sea water. The following table (VI.) gives the result of his investigations. One litre (1000 volumes) of ocean water when saturated with constantly renewed air at $t°$, and a pressure of 760 millimètres[1] plus tension of steam at $t°$ C., takes up the following volumes, measured dry at 0° C. and 760 millimètres pressure,[1] of the pure gases.

Temperature.	Dissolved Nitrogen and Oxygen in Cubic Centimetres (volumes).		Percentage of Oxygen in Dissolved Gas.
C.	Nitrogen.	Oxygen.	
0°	15·60	8·18	34·40
5°	13·86	7·22	34·24
10°	12·47	6·45	34·09
15°	11·34	5·83	33·93
20°	10·41	5·31	33·78
25°	9·62	4·87	33·62
30°	8·94	4·50	33·47
35°	8·36	4·17	33·31

The method used for obtaining these numbers adapted itself closely to the one which Buchanan had employed for extracting the gas samples. In the calculations it was assumed that atmospheric air contains 21·0 volumes of oxygen for 79·0 volumes of nitrogen, the slight variation in this ratio, which is known to occasionally present itself, being neglected. From the table we can calculate approximately the limits between which the proportions of dissolved oxygen and nitrogen in the water of the ocean must be presumed to oscillate in nature. The pressure of the atmosphere at the sea-level, though by no means constant, is never far removed from that of 760 mm. of mercury. The temperature of the surface water (with rare exceptions) may be said to vary from − 2° C. (in the liquid part of the ocean in the arctic and antarctic regions) to about 30° C. (in the tropics). The ocean receives all its dissolved oxygen and nitrogen from the surface; neither gas comes in from below, except perhaps a relatively insignificant quantity of nitrogen derived from the decay of dead organisms, which may safely be neglected. Hence the ocean can contain nowhere more than 15·6 c.c. of nitrogen or more than 8·18 c.c. of oxygen per litre, and the nitrogen will never fall below 8·55 c.c. We cannot make a similar assertion in regard to the oxygen, because its theoretical minimum of 4·30 c.c. per litre is liable to further diminution by processes of life and putrefaction and by oxidation generally.[2]

At any point in the surface of the ocean the water constantly tends to assume the composition demanded for the prevailing temperature by the laws of gas absorption. But it is rarely possible for it to assume this composition, owing to the water being in a continual state of motion; and, supposing a certain area of the ocean surface were in a state of stagnation, the temperature would vary in diurnal cycles, and even the calculated volume of nitrogen per litre would be a periodic function of time, exhibiting its maximum at the hour of minimum temperature, and *vice versa*. The process of absorptiometric exchange, however, even at the constantly oscillating surface of the ocean, is slow; it could not keep pace with the change of temperature, and the actual nitrogen curve would never go as high up or as low down as the theoretical one. In addition to this, the lower strata of the water constantly add to, or take away from, the surface nitrogen by diffusion and occasional intermixture. All this holds for the oxygen likewise, except that it is liable to constant diminution by oxidation. On the whole we may assume that all the disturbing influences will only modify, not efface, the course of events as prescribed by the laws of gas-absorption.

In regard to non-surface water we have to confront a greater complexity of phenomena. The gas-contents of deep-sea water, of course, have nothing to do with the low temperature and the high pressure which in general prevail there. For the purpose of a preliminary survey, let us imagine a deep-sea water formed from one kind of surface water, which took up its air at a constant temperature (t), and then sank down unmixed with other waters. The volumes of the oxygen and nitrogen per litre have at first the values assigned to them by the laws of gas absorption. But, while the nitrogen (as long as the water remains unmixed with other water) remains constant, the oxygen will become less and less through the processes of oxidation which go on in the deep without compensation. Hence if there were absolute stagnation in the ocean anywhere the proportion of oxygen there might be reduced ultimately to nothing. Among the many "Challenger" deep-sea specimens which were analysed for their gas-contents none was found quite free from absorbed oxygen; and this confirms the conclusion that absolute stagnation exists nowhere in the ocean, not even at its greatest depth. Occasionally, however, the oxygen was found to have sunk down to very little, as shown by the following two examples:—

No. of Sample.	C.c. per Litre of Nitrogen.	C.c. per Litre of Oxygen.	C.c. of Oxygen calculated from Nitrogen.	Depth in Fathoms.
1001	15·08	0·6	8·21	2875
1645	13·38	2·04	6·95	1500

There must have been an approximation to absolute rest at these two places at any rate. On the whole, the results of the gas analysis, as interpreted on the basis of Dittmar's absorptiometric determinations, agreed fairly well with the inferences which we have just been deducing from physical laws. There was no lack of anomalous results, but it was not found possible to trace them to natural causes. The equilibrium in regard to the absorbed nitrogen and oxygen in the ocean is maintained by the atmosphere; and, from the fact that the air contained in surface water is always richer in oxygen than is atmospheric air, one naturally concludes that the ocean should constantly add to the percentage of oxygen in the air in the tropics and constantly diminish it in the colder latitudes. But Regnault's numerous air-analyses do not confirm this. Nor need this be wondered at, since, as we have seen, even the corresponding influence on the atmospheric carbonic acid has so far defied the powers of chemical analysis.

Salinity of Ocean Water.—Even in the open ocean the "salinity"—meaning in a given quantity the ratio between the weight of dissolved salt and the weight or volume of the whole—is subject to considerable variation; and it obviously is one of the foremost duties of observing oceanographers to collect the data by means of which it may be possible one day to represent that quantity mathematically as a function of geographic position, depth, and time. For the quantitative determination of the salinity an obvious, easy, and sufficient method is to determine the specific gravity S at a convenient temperature t; this in fact is the method which has so far been employed by all observers almost to the exclusion of every other. Buchanan used it during the "Challenger" cruise perhaps more extensively than any of his predecessors had done. Of the arithmetical relation between salinity on the one hand and S and t on the other the successive researches of Ekman (as supplemented by Tornöe), Thorpe and Rücker, Dittmar, and others have given us a practically sufficient knowledge. According to Dittmar the function (within the limits of Buchanan's values) coincides practically with the formula

$$ {}_4S_t - {}_4W_t = \chi(a + bt + ct^2), $$

where ${}_4S_t$ means the specific gravity at $t°$ C. referred to that of pure water of +4° C. as equal to 1000; ${}_4W_t$ has a similar meaning in reference to pure water; χ stands for the weight of total halogen calculated as chlorine per 1000 parts, by weight, of sea water; and $a=1·45993$, $b=-0·005592$, $c=+0·0000649$. For oceanographic purposes, however, it is not necessary to go back to χ; it suffices from series of values ${}_4S_t$ to deduce the corresponding values ${}_4S_{t_0}$ for a convenient standard temperature, and to reason on these reduced numbers as if they measured the salinity, just as we take the readings of a thermometer as in themselves representing "temperatures." This, in fact, is always done; only unfortunately different standard temperatures have been chosen by different observers; Buchanan adopted 15°·56 C. = 60° Fahr. Before going further, let us observe that the specific gravity of sea water, taking it as it is *in situ*, has an important oceanographic significance, even as such. But this quantity in the case of deep-sea waters is influenced very largely[3] by the pressure of the superincumbent layer of water—which in itself is a complex function of the successive temperatures and salinities—and unfortunately we still lack the constants and formulæ for making the necessary reductions with adequate exactitude. Meanwhile all our statistics of sea water specific gravities, valuable as they are, constitute statistics of only salinities and nothing else.

At the surface of the ocean the salinity is liable chiefly to three influences,—(1) concentration by formation of ice or by the action of dry winds; (2) dilution through the melting of ice or the falling of rain; (3) concentration or dilution through the virtual addition of salt or water by inflowing currents of salter or fresher water respectively. The effect of the formation or melting of ice, though great within the arctic circles, does not tell much on the non-polar seas. More important in regard to these is the effect of the south-east and the north-east trade winds, which in the Pacific blow between about 3° and 21° S. lat. and between about 2° and 20° N. lat. respectively, leaving between the two a belt of 5° of a region of calms (see more exactly, METEOROLOGY, vol. xvi. p. 144). In the Atlantic the limiting lines of both trades oscillate annually, so that the equatorial boundary of the north-east trade shifts from 3° to 11° N. lat., and that of the south-east trade from about 1° to 3° *N.* lat.

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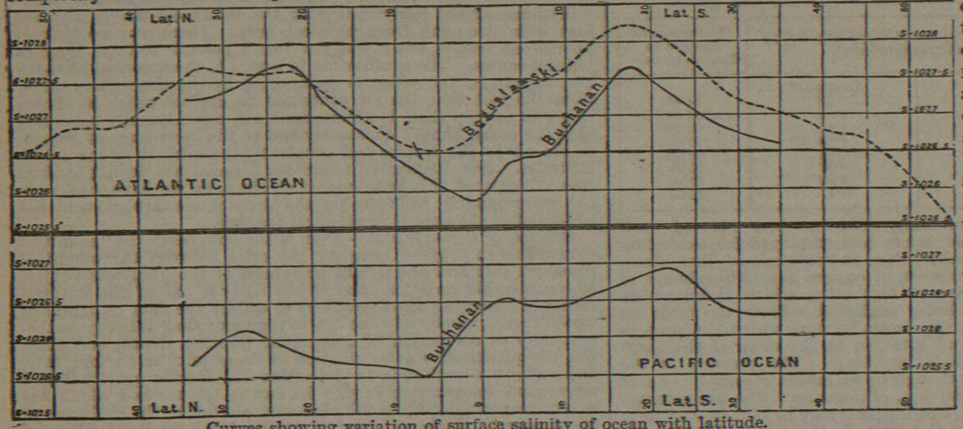
[1] Theoretically any number may be substituted for 760; for calculating purposes read "1 millimètre."

[2] In calculating these limit values the tension of the vapour of water is taken into account; hence the apparent non-agreement with the entries in the table.

[3] According to Grassi's experiments, if sea water under the pressure of one atmosphere has the specific gravity 1026, it assumes at depths = 1000, 2000, 3000 fathoms a density of 1026 + 1, 2, 3 times 7·9 units = 1033·9, 1041·8, 1049·7 respectively.

Both trades blowing from colder into warmer regions absorb water largely and thus raise the salinity within their areas of action. The western anti-trades which blow on the polar sides of the two trades, passing from hotter to colder regions, should dilute the ocean there; but they do not seem to act so powerfully in this direction as might be expected. In the belt of equatorial calms between the two trades abundant rains fall frequently and dilute the water very perceptibly.



Curves showing variation of surface salinity of ocean with latitude.

What has been said thus far about the distribution of surface salinity applies chiefly to the Atlantic, which in fact is far more completely known in this respect than any other ocean. The accompanying diagram shows how on the average the surface salinity varies there with the latitude. The bolder curve is drawn after a table given by Buchanan in his part of the *Narrative of the Cruise of the "Challenger,"* the other after a more extensive table given by Boguslawski as embodying the mean results of many observations by different authorities with reference to standard temperatures varying from 15° to 17°·5 C.,—coast waters affected by the influx of large rivers having been omitted.[1] In the North Atlantic there is an area of maximum (surface) salinity ($S=1028{\cdot}5$) between 25° and 35° N. lat. and 30° and 20° W. long. The zone of minimum salinity lies between 15° N. lat. and the equator. In the South Atlantic (surface) there are two concentration centres,—an eastern about St Helena and between that island and Ascension, and a western north of San Trinidad,—both nearer the equator than that of the North Atlantic. As pointed out by Buchanan, a relatively high salinity (not merely on the surface) is quite a characteristic feature of the Atlantic, and in its northern part prevails up to the high latitudes of the Norwegian Sea, which was so thoroughly investigated by Swensden (1876) and Tornöe (1877 and 1878) during the Norwegian expeditions. The salt (and heat) conveying influence of the Gulf Stream makes itself felt up to Spitzbergen (76° N. lat.). On both sides of the Faroe Islands the specific gravity ${}_{17{\cdot}5}S_{17{\cdot}5}$ comes up to 1027·0; at the Bear Islands it sinks to 1026·7, and thence farther northwards to 1026·1. While the Gulf Stream pushes northwards, a current of relatively fresh polar water travels southwards and, creeping along the eastern coast of the United States, forms what is known as the "cold wall." In passing from the surface to the depth of the ocean the general rule (Buchanan) is that the actual specific gravity *in situ* increases with the depth; but this does not hold for the salinity (or specific gravity reduced to standard temperature). In places where there is active dilution at the surface (*e.g.*, in the belt of equatorial calms) the salinity as a rule increases down to some 50 or 100 fathoms; but thence downwards it follows the general rule, that is, it *decreases* down to 800 or 1000 fathoms, and thence increases steadily to the bottom. In the South Atlantic the salinity of the bottom water has an almost constant value (${}_{4}S_{15{\cdot}5}=1025{\cdot}7$ to $1025{\cdot}9$); but northwards it increases to from 1026·16 to 1026·32 at 2000 to 4000 fathoms (Buchanan).

In regard to the Pacific our knowledge is far less complete. A glance at the curve shows that the (surface) salinity at a given latitude is less there than it is in the Atlantic. In the whole of the Pacific there is only one concentration centre, which lies about the Society Islands, with a maximum salinity corresponding to ${}_{4}S_{15{\cdot}5}=1027{\cdot}19$. (W. D.)

SEA-WOLF, also Sea-cat and Wolf-fish (*Anarrhichas lupus*), a marine fish, the largest kind of the family *Blenniidæ* or Blennies. In spite of its large size, it has retained the bodily form and general external characteristics of the small blennies, which are so abundant on every rocky part of the coast. Its body is long, subcylindrical in front, compressed in the caudal portion, smooth and slippery, the rudimentary scales being embedded and almost hidden in the skin. An even dorsal fin extends along the whole length of the back, and a similar fin from the vent to the caudal fin, as in blennies. But its formidable dentition distinguishes the sea-wolf from all the other members of the family. Both jaws are armed in front with strong conical teeth, and on the sides with two series of large tubercular molars, a biserial band of similar molars occupying the middle of the palate. By these teeth the sea-wolf is able to crush the hard carapaces or shells of the crustaceans and molluscs on which it feeds; but whether it uses the teeth as a weapon of defence and deserves the character of ferocity generally attributed to it would appear to be rather questionable from observations made on specimens in the aquarium at Hamburg, which allowed themselves to be handled without in any way resenting the loss of their liberty. It must, however, be added that the small blennies bite readily when caught. Sea-wolves are inhabitants of the northern seas of both hemispheres, one (*A. lupus*) being common on the coasts of Scandinavia and North Britain, and two in the seas round Iceland and Greenland. Two others occur in the corresponding latitudes of the North Pacific. They attain to a length exceeding 6 feet, and in the north are esteemed as food, both fresh and preserved. The oil extracted from the liver is said to be in quality equal to the best cod-liver oil. Of late years small numbers have reached the English markets, where, however, the prejudice which attaches to all scaleless fishes, particularly such as possess a varied pattern of coloration, limits their use as food.

Teeth of the lower and upper jaws of the sea-wolf.

SEBASTE. See Sivas.

SEBASTIAN, Dom. See Portugal, vol. xix. pp. 546-547.

SEBASTIAN, St, the patron saint against plague and pestilence, was by birth a Narbonese. According to the Roman breviary his nobility and bravery had endeared him to the emperor Diocletian, who made him captain of the first cohort. Having secretly become a Christian, he was wont to encourage those of his brethren who in the hour of trial seemed wavering in their profession. This was conspicuously the case when the brothers Marcus and Marcellinus were being led forth to death; by his exhortations he prevailed on them to resist the entreaties and tears of their wives and children. The emperor having been informed of this conduct sent for him and earnestly remonstrated with him, but, finding him inflexible, ordered that he should be bound to a stake and shot to death. After the archers had left him for dead a devout woman, Irene, came by night to take his body away for burial, but, finding him still alive, carried him to her house, where his wounds were dressed. No sooner had he wholly recovered than he hastened to confront the emperor, reproaching him with his impiety; Diocletian, filled with astonishment, which soon changed into fury, ordered him to be instantly carried off and beaten to death with rods (288). The sentence was forthwith executed, his body being thrown into the cloaca, where, however, it was found by another pious matron, Lucina, whom Sebastian visited in a dream, directing her to bury him in the Catacombs under the site of the church now called by his name. He is celebrated by the Roman Church on 20th January (duplex). His cult is chiefly diffused along the eastern coast of Italy and in other districts liable to visitations of plague. As a young and beautiful soldier, he is a favourite subject of sacred art, being most generally represented as undraped and severely, though not mortally, wounded with arrows.

SEBASTIANO DEL PIOMBO (1485-1547), painter, was born at Venice in 1485, and belongs to the Venetian school, exceptionally modified by the Florentine or Roman. His family name was Luciani. He was at first a musician, chiefly a solo-player on the lute, and was in great request among the Venetian nobility. He soon showed a turn for painting, and became a pupil of Giovanni Bellini and afterwards of Giorgione. His first painting of note was done for the church of St John Chrysostom in Venice, and is so closely modelled on the style of Giorgione that in its author's time it often passed for the work of that master. It represents Chrysostom reading aloud at a desk, a grand Magdalene in front, and two other female and three male saints. Towards 1512 Sebastiano was invited to Rome by the wealthy Sienese merchant Agostino Chigi, who occupied a villa by the Tiber, since named the Farnesina; he executed some frescos here, other leading artists being employed at the same time. The Venetian mode of colour was then a startling novelty in Rome. Michelangelo saw and approved the work of Luciani, became his personal friend, and entered into a peculiar arrangement with him. At this period the pictorial ability of Michelangelo (apart from his general power as an artist, regarding which there arose no question) was somewhat decried in Rome, the rival faculty of Raphael being invidiously exalted in comparison; in especial it was contended that Buonarroti fell short as a colourist. He therefore thought that he might try whether, by furnishing designs for pictures and leaving to Sebastiano the execution of them in colour, he could not maintain at its highest level his own general supremacy in the art, leaving Raphael to sustain the competition as he best might. In this there seems to have been nothing particularly unfair, always assuming that the compact was not fraudulently concealed; and the facts are so openly stated by Michelangelo's friend Vasari (not to speak of other writers) that there appears to have been little or no disguise in the matter. Besides, the pictures are there to speak for themselves; and connoisseurs have always acknowledged that the quality of Michelangelo's unmatched design is patent on the face of them. Of late years, however, some writers, unnecessarily jealous for Buonarroti's personal rectitude, have denied that his handiwork is to be traced in the pictures bearing the name of Sebastiano. Four leading pictures which Sebastiano painted in pursuance of his league with Buonarroti are the Pietà (earliest of the four), in the church of the Conventuali, Viterbo; the Transfiguration and the Flagellation, in the church of S. Pietro in Montorio, Rome; and, most celebrated of all, the Raising of Lazarus, now in the London National Gallery. This grand work—more remarkable for general strength of pictorial perception than for qualities of detailed intellectual or emotional expression—is more than 12 by 9 feet in dimensions, with the principal figures of the natural size; it is inscribed "Sebastianus Venetus faciebat," and was transferred from wood to canvas in 1771. It was painted in 1517-19 for Giulio de' Medici, then bishop of Narbonne, afterwards Pope Clement VII.; and it remained in Narbonne cathedral until purchased by the duke of Orleans early in the 18th century,—coming to England with the Orleans gallery in 1792. It is generally admitted that the design of Michelangelo appears in the figure of Lazarus and of those who are busied about him (the British Museum contains two sketches of the Lazarus regarded as Michelangelo's handiwork); but whether he actually touched the panel, as has often been said, appears more than doubtful, as he left Rome about the time when the picture was commenced. Raphael's Transfiguration was painted for the same patron and the same destination. The two works were exhibited together, and some admirers did not scruple to give the preference to Sebastiano's. The third of the four pictures above mentioned, the Flagellation of Christ, though ordinarily termed a fresco, is, according to Vasari, painted in oil upon the wall. This was a method first practised by Domenico Veneziano, and afterwards by some other artists; but Sebastiano alone succeeded in preventing the blackening of the colours. The contour of the figure of Christ in this picture is supposed by many to have been supplied by Buonarroti's own hand. Sebastiano, always a tardy worker, was occupied about six years upon this work, along with its companion the Transfiguration, and the allied figures of saints.

After the elevation of Giulio de' Medici to the pontificate, the office of the "piombo" or leaden seal—that is, the office of sealer of briefs of the apostolic chamber—became vacant; two painters competed for it, Sebastiano Luciani, hitherto a comparatively poor man, and Giovanni da Udine. Finally Sebastiano, assuming the habit of a friar, secured the very lucrative appointment,—with the proviso, however, that he should pay out of his emoluments 300 scudi per annum to Giovanni. If he had heretofore been slow in painting, he became now supine and indifferent in a marked degree. He lived on the fat of the land, cultivated sprightly literary and other society, to which he contributed his own full quota of amusement, and would scarcely handle a brush, saying jocularly that he benefited the profession by leaving all the more work for other artists to do. Berni, one of his intimates, addressed a *capitolo* to him, and Sebastiano responded in like versified form. One of the few subject-pictures which he executed after taking office was Christ carrying the Cross for the patriarch of Aquileia, also a Madonna with the body of Christ. The former painting is done on stone, a method invented by Sebastiano himself. He likewise painted at times on slate,—as in the instance of Christ on the Cross, now in the Berlin gallery, where the slate constitutes the background. In the same method, and also in the same gallery, is the Dead Christ supported by Joseph of Arimathea, with a weeping Magdalene,—colossal half-length figures. Late in life Sebastiano had a serious disagreement with Michelangelo with reference to the Florentine's great picture of the Last Judgment. Sebastiano encouraged the pope to insist that this picture should be executed in oil. Michelangelo, determined from the first upon nothing but fresco, tartly replied to his holiness that oil was only fit for women and for sluggards like Friar Sebastian; and the coolness between the two painters lasted almost up to the friar's death. This event, consequent upon a violent fever acting rapidly upon a

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[1] For the sake of comparison there is shown on the lower part of the diagram the surface salinity curve for the Pacific drawn after Buchanan's summary tabulation of his results.

very sanguine temperament, took place at Rome in 1547. Sebastiano directed that his burial, in the church of S. Maria del Popolo, should be conducted without ceremony of priests, friars, or lights, and that the cost thus saved should go to the poor; in this he was obeyed.

Numerous pupils sought training from Sebastiano del Piombo; but, owing to his dilatory and self-indulgent habits, they learned little from him, with the exception of Tommaso Laureti. Sebastiano, conscious of his deficiency in the higher sphere of invention, made himself especially celebrated as a portrait painter: the likeness of Andrea Doria, in the Doria Palace, Rome, is one of the most renowned. In the London National Gallery are two fine specimens: one canvas represents the friar himself, along with Cardinal Ippolito de' Medici; the other, a portrait of a lady in the character of St Agatha, used to be identified with one of Sebastiano's prime works, the likeness of Julia Gonzaga (painted for her lover, the aforenamed cardinal), but this assumption is now discredited. There were also portraits of Marcantonio Colonna, Vittoria Colonna, Ferdinand marquis of Pescara, Popes Adrian VI., Clement VII. (Studj Gallery, Naples), and Paul III., Sanmicheli, Anton Francesco degli Albizzi, and Pietro Aretino. One likeness of the last-named sitter is in Arezzo and another in the Berlin gallery.

SEBASTOPOL, or **Sevastopol**, the chief naval station of Russia on the Black Sea, is situated in the south-west of the Crimea, in 44° 37′ N lat. and 33° 31′ E. long., 935 miles from Moscow, with which it is connected by rail *via* Kharkoff. The estuary, which is one of the best roadsteads in Europe and could shelter the combined fleets of Europe, is a deep and thoroughly sheltered indentation among chalky cliffs, running east and west for nearly 3¾ miles, with a width of three-quarters of a mile, narrowing to 930 yards at the entrance, where it is protected by two small promontories. It has a depth of from 6 to 10 fathoms, with a good bottom, and large ships can anchor at a cable's length from the shore. The main inlet has also four smaller indentations,—Quarantine Bay at its entrance, Yuzhnaya (Southern) Bay, which penetrates more than a mile to the south, with a depth of from 4 to 9 fathoms, Dockyard Bay, and Artillery Bay. A small river, the Tchornaya, enters the head of the inlet. The main part of the town, with an elevation ranging from 30 to 190 feet, stands on the southern shore of the chief inlet, between Yuzhnaya and Artillery Bays. To the east are situated the barracks, hospitals, and storehouses; a few buildings on the other shore of the chief bay constitute the "northern side." Before the Crimean War of 1853-56 Sebastopol was a well-built city, beautified by gardens, and had 43,000 inhabitants; but at the end of the siege it had not more than fourteen buildings which had not been badly injured. After the war many privileges were granted by the Government in order to attract population and trade to the town; but both increased slowly, and at the end of seven years its population numbered only 5750. The railway line connecting Sebastopol with Moscow gave some animation to trade, and it was thought at the time that Sebastopol, although precluded by the treaty of Paris from reacquiring its military importance, might yet become a commercial city. In November 1870, during the Franco-German War, the Russian Government publicly threw off the obligation of those clauses of the treaty of Paris which related to the Black Sea fleet and fortresses, and it was decided again to make Sebastopol a naval arsenal. In 1882 Sebastopol had a population of 26,150 inhabitants, largely military. The town has been rebuilt on a new plan, and a fine church occupies a prominent site. There are now two lyceums and a zoological marine station. Although belonging to the government of Taurida, Sebastopol and its environs are under a separate military governor.

The peninsula between the Bay of Sebastopol and the Black Sea became known in the 7th century as the Heracleotic Chersonese (see vol. vi. p. 587). In the 5th century B.C. a Greek colony was founded here and remained independent for three centuries, when it became part of the kingdom of the Bosphorus, and subsequently tributary to Rome. Under the Byzantine emperors Chersonesus was an administrative centre to their possessions in Taurida. According to the Russian annals, Vladimir, prince of Kieff, conquered Chersonesus (Korsuñ) before being baptized there, and restored it to the Greeks on marrying the princess Anna. Subsequently the Slavonians were cut off from relations with Taurida by the Mongols, and only made occasional raids, such as that of the Lithuanian prince Olgerd. In the 16th century a new influx of colonizers, the Tatars, occupied Chersonesus and founded a settlement named Akhtiar. This village, after the Russian conquest in 1783, was selected for the chief naval station of the empire in the Black Sea and received its present name ("The August City"). In 1826 strong fortifications were begun, and in 1853 it was a formidable fortress. In September 1854, after having defeated the Russians in the battle of the Alma, the Anglo-French laid siege to the southern portion of the town, and on 17th October began a heavy bombardment. Sebastopol, which was nearly quite open from the land, was strengthened by earthworks thrown up under the fire of the besiegers, and sustained a memorable eleven months' siege. On 8th September 1855 it was evacuated by the Russians, who retired to the north side. The fortifications were blown up by the allies, and by the Paris treaty the Russians were bound not to restore them.

SEBENICO (*Sibenik*), a town of Austrian Dalmatia, on the coast of the Adriatic, about half-way between Zara and Spalato, is situated on an irregular basin at the mouth of the Kerka, connected with the sea by a winding channel 3 miles long. The channel is defended by a fort designed by Sanmicheli, and the town itself, picturesquely situated on the abrupt slope of a rocky hill, is guarded by three old castles, now dismantled. There is also a wall on the landward side. Sebenico is the seat of a bishop, and its Italian Gothic cathedral, dating from the 15th and 16th centuries, is considered the finest church in Dalmatia. Its excellent harbour and its situation at the entrance of the Kerka valley combine to make Sebenico the entrepôt of a considerable trade. Fishing is carried on extensively. The population of the commune in 1880 was 18,104, of the town proper about 8000.

SECCHI, Angelo (1818-1878), Italian astronomer, was born on 29th June 1818 at Reggio in Lombardy, and entered the Society of Jesus at an early age. In 1849 he was appointed director of the observatory of the Collegio Romano, which was rebuilt in 1853; there he devoted himself with great perseverance to researches in physical astronomy and meteorology till his death at Rome on 26th February 1878.

The results of Secchi's observations are contained in a great number of papers and memoirs. From about 1864 he occupied himself almost exclusively with spectrum analysis, both of stars (*Catalogo delle Stelle di cui si è determinato lo Spettro Luminoso*, Paris, 1867, 8vo; "Sugli Spettri Prismatici delle Stelle Fisse," two parts, 1868, in the *Atti della Soc. Ital.*) and of the sun (*Le Soleil*, Paris, 1870, 8vo; 2d ed. 1877). Though his publications always bear witness of his indefatigable zeal and energy, they are often uncritical and wanting in accuracy.

SECKENDORF, Veit Ludwig von (1626-1692), a German statesman and scholar of the 17th century, was the most distinguished member of an ancient and widespread German noble family, which took its name from the village Seckendorf between Nuremberg and Langenzenn, and is said to have been ennobled by the emperor Otho I. in 950, though it traces its own genealogy no further back than 1262. The family was divided into eleven distinct lines, but at present only three are preserved, widely distributed throughout Prussia, Würtemberg, and Bavaria.[1] Veit Ludwig von Seckendorf, son of Joachim Ludwig, of the Gudentine line, was born at Herzogenaurach (near Erlangen) in Upper Franconia, 20th December 1626. His youth fell in the midst of the Thirty Years' War, in which his father was actively engaged. But his talented and noble mother carefully watched over his education. In Coburg, Mühlhausen, and finally in Erfurt, whither his mother removed in 1636, he acquired the Latin, Greek, and French languages. In 1639 he returned to Coburg, and the reigning duke, Ernest the Pious, made him his *protégé*. Entering the university of Strasburg in 1642, he devoted himself to history and jurisprudence. After he finished his university course his patron gave him an appointment in his court at Gotha, with the charge of his valuable library. He there laid the foundation of his great collection of historical materials and mastered the principal modern languages. In 1652 he was appointed to important judicial positions and sent on weighty embassages. In 1656 he was made judge in the ducal court at Jena, a position which he held many years and in which he took the leading part in the numerous beneficent reforms of the duke. In 1664 he resigned office under Duke Ernest, who had just made him chancellor and with whom he continued on excellent terms, and entered the service of Duke Maurice of Zeitz (Altenburg), with the view of lightening his official duties. After the death of Maurice in 1681 he retired to his estate, Meuselwitz in Altenburg, from nearly all public offices, and devoted himself to his intellectual labours. Although living in retirement, he kept up a correspondence with the principal learned men of the day. He was especially interested in the endeavours of the pietist Spener to effect a practical reform of the German church, although he was hardly himself a pietist. In 1692 he was appointed chancellor of the new university of Halle, but died a few weeks afterwards, on the 18th of December.

Seckendorf's principal works were the following:—*Deutscher Fürstenstaat* (1656 and often afterwards), a handbook of German public law; *Der Christenstaat* (1685), partly an apology for Christianity and partly suggestions for the reformation of the church, founded on Pascal's *Pensées* and embodying the fundamental ideas of Spener; *Commentarius historicus et apologeticus de Lutheranismo sive de Reformatione* (3 vols., Leipsic, 1692) occasioned by the Jesuit Maimbourg's *Histoire du Luthéranisme* (Paris, 1680), his most important work, and still indispensable to the historian of the Reformation as a rich storehouse of authentic materials.

See D. G. Schreber's *Historia vitæ ac meritorum Viti Ludovici a Seckendorf* (Leipsic, 1733); Schröckh, *Lebensbeschreibungen berühmter Männer* (Leipsic, 1790); Nasemann, "Veit Ludwig von Seckendorf," in *Preussische Jahrbücher* (vol. xii., 1863, p. 257 *sq.*); W. Roscher, "Zwei sächsische Staatswirthe im 16ten und 17ten Jahrhundert," in *Weber's Archiv für die sächsische Geschichte* (vol. i., 1862); and Theodor Kolde, "Seckendorf," in Herzog-Plitt's *Realencyklopädie* (1884).

SECRETARY-BIRD, a very singular African animal first accurately made known, from an example living in the menagerie of the prince of Orange, in 1769 by Vosmaer,[1] in a treatise published simultaneously in Dutch and French, and afterwards included in his collected works issued, under the title of *Regnum Animale*, in 1804. He was told that at the Cape of Good Hope this bird was known as the "Sagittarius" or Archer, from its striding gait being thought to resemble that of a bowman advancing to shoot, but that this name had been corrupted into that of "Secretarius." In August 1770 Edwards saw an example (apparently alive, and the survivor of a pair which had been brought to England) in the possession of Mr Raymond near Ilford in Essex; and, being unacquainted with Vosmaer's work, he figured and described it as "of a new genus" in the *Philosophical Transactions* for the following year (lxi. pp. 55, 56, pl. ii.). In 1776 Sonnerat (*Voy. Nouv. Guinée*, p. 87, pl. 50) again described and figured, but not at all correctly, the species, saying (but no doubt wrongly) that he found it in 1771 in the Philippine Islands. A better representation was given by D'Aubenton in the *Planches Enluminées* (721); in 1780 Buffon (*Oiseaux*, vii. p. 330) published some additional information derived from Querhoent, saying also that it was to be seen in some English menageries; and the following year Latham (*Synopsis*, i. p. 20, pl. 2) described and figured it from three examples which he had seen alive in England. None of these authors, however, gave the bird a scientific name, and the first conferred upon it seems to have been that of *Falco serpentarius*, inscribed on a plate bearing date 1779, by John Frederick Miller (*Ill. Nat. History*, xxviii.), which plate appears also in Shaw's *Cimelia Physica* (No. 28) and is a misleading caricature. In 1786 Scopoli called it *Otis secretarius*—thus referring it to the Bustards,[2] and Cuvier in 1798 designated the genus to which it belonged, and of which it still remains the sole representative,[3] *Serpentarius*. Succeeding systematists have, however, encumbered it with many other names, among which the generic terms *Gypogeranus* and *Ophiotheres*, and the specific epithets *reptilivorus* and *cristatus*, require mention here.[4] The Secretary-bird is of remarkable appearance, standing nearly 4 feet in height, the great length of its legs giving it a resemblance to a Crane or a Heron; but the expert will at once notice that, unlike those birds, its tibiæ are feathered all the way down. From the back of the head and the nape hangs, loosely and in pairs, a series of black elongated feathers, capable of erection and dilation in periods of excitement.[5]

Secretary-Bird.

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[1] Amongst the Seckendorfs less known to fame than Veit Ludwig are his nephew, Friedrich Heinrich (1673-1763), soldier and diplomatist; Leo (1773-1809), poet, literary man, and soldier; the brothers Christian Adolf (1767-1833) and Gustav Anton ("Patrik Peale") (1775-1823) both literary men of some note.

[1] Le Vaillant (*Sec. Voy. Afrique*, ii. p. 273) truly states that Kolben in 1719 (*Caput Bonæ Spei hodiernum*, p. 182, French version, ii. p. 198) had mentioned this bird under its local name of "Snake-eater" (*Slangenvreeter*, Dutch translation, i. p. 214); but that author, who was a bad naturalist, thought it was a Pelican and also confounded it with the Spoonbill, which is figured to illustrate his account of it. Though he doubtless had seen, and perhaps tried to describe, the Secretary-bird, he certainly failed to convey any correct idea of it. Latham's suggestion (*loc. infra cit.*) that the figure of the "Grus Capensis cauda cristata" in Petiver's *Gazophylacium* (tab. xii. fig. 12) was meant for this bird is negatived by his description of it (p. 20). The figure was probably copied from one of Sherard's paintings and is more likely to have had its origin in a Crane of some species. Vosmaer's plate is lettered "Amerikaanischen Roof-Vogel," of course by mistake for "Afrikaanischen."

[2] Curiously enough, Boddaert in 1783 omitted to give it a scientific name.

[3] Ogilby's attempt to distinguish three species (*Proc. Zool. Society*, 1835, pp. 104, 105) has met with no encouragement; but examples from the north of the equator are somewhat smaller than those from the south.

[4] The scientific synonymy of the species is given at great length by Drs Finsch and Hartlaub (*Vögel Ost-Afrikas*, p. 93) and by Mr Sharpe (*Cat. B. Brit. Museum*, i. p. 45); but each list has some errors in common.

[5] It is from the fancied resemblance of these feathers to the pens which a clerk is supposed to stick above his ear that the bird's name of Secretary is really derived.