CHAPTER VII

PISCES, ARIES, TAURUS, AND THE NORTHERN STARS

"Now sing we stormy skies when Autumn weighs
The year, and adds to nights and shortens days,
And suns declining shine with feeble rays."--DRYDEN'S VIRGIL.

The eastern end of Pisces, represented in map No. 22, includes most of the interesting telescopic objects that the constellation contains. We begin our exploration at the star numbered 55, a double that is very beautiful when viewed with the three-inch glass. The components are of magnitudes five and eight, distance 6.6", p. 192°. The larger star is yellow and the smaller deep blue. The star 65, while lacking the peculiar charm of contrasted colors so finely displayed in 55, possesses an attraction in the equality of its components which are both of the sixth magnitude and milk-white. The distance is 4.5", p. 118°. In 66 we find a swift binary whose components are at present far too close for any except the largest telescopes. The distance in 1894 was only 0.36", p. 329°. The magnitudes are six and seven. In contrast with this excessively close double is psi, whose components are both of magnitude five and a half, distance 30", p. 160°. Dropping down to 77 we come upon another very wide and pleasing double, magnitudes six and seven, distance 33", p. 82°, colors white and lilac or pale blue. Hardly less beautiful is zeta magnitudes five and six, distance 24", p. 64°. Finest of all is alpha, which exhibits a remarkable color contrast, the larger star being greenish and the smaller blue. The magnitudes are four and five, distance 3", p. 320°. This star is a binary, but the motion is slow. The variable R ranges between magnitudes seven and thirteen, period three hundred and forty-four days.

The constellation Aries contains several beautiful doubles, all but one of which are easy for our smallest aperture. The most striking of these is gamma, which is historically interesting as the first double star discovered. The discovery was made by Robert Hooke in 1664 by accident, while he was following the comet of that year with his telescope. He expressed great surprise on noticing that the glass divided the star, and remarked that he had not met with a like instance in all the heavens. His observations could not have been very extensive or very carefully conducted, for there are many double stars much wider than gamma Arietis which Hooke could certainly have separated if he had examined them. The magnitudes of the components of gamma are four and four and a half, or, according to Hall, both four; distance 8.5", p. 180°. A few degrees above gamma, passing by beta, is a wide double lambda, magnitudes five and eight, distance 37", p. 45°, colors white and lilac or violet. Three stars are to be seen in 14: magnitudes five and a half, ten, and nine, distances 83", p. 36°, and 106", p. 278°, colors white, blue, and lilac. The star 30 is a very pretty double, magnitudes six and seven, distance 38.6", p. 273°. Sigma 289 consists of a topaz star combined with a sapphire, magnitudes six and nine, distance 28.5", p. 0°. The fourth-magnitude star 41 has several faint companions.

The magnitudes of two of these are eleven and nine, distances 34", p. 203°, and 130", p. 230°. We discover another triple in pi, magnitudes five, eight, and eleven, distances 3.24", p. 122°, and 25", p. 110°. The double mentioned above as being too close for our three-inch glass is epsilon, which, however, can be divided with the four-inch, although the five-inch will serve us better. The magnitudes are five and a half and six, distance 1.26", p. 202°. The star 52 has two companions, one of which is so close that our instruments can not separate it, while the other is too faint to be visible in the light of its brilliant neighbor without the aid of a very powerful telescope.

We are now about to enter one of the most magnificent regions in the sky, which is hardly less attractive to the naked eye than Orion, and which men must have admired from the beginning of their history on the earth, the constellation Taurus (map No. 23). Two groups of stars especially distinguish Taurus, the Hyades and the Pleiades, and both are exceedingly interesting when viewed with the lowest magnifying powers of our telescopes.

We shall begin with a little star just west of the Pleiades, Sigma 412, also called 7 Tauri. This is a triple, but we can see it only as a double, the third star being exceedingly close to the primary. The magnitudes are six and a half, seven, and ten, distances 0.3", p. 216°, and 22", p. 62°. In the Pleiades we naturally turn to the brightest star eta, or Alcyone, famous for having once been regarded as the central sun around which our sun and a multitude of other luminaries were supposed to revolve, and picturesque on account of the little triangle of small stars near it which the least telescopic assistance enables us to see. One may derive much pleasure from a study of the various groupings of stars in the Pleiades. Photography has demonstrated, what had long been suspected from occasional glimpses revealed by the telescope, that this celebrated cluster of stars is intermingled with curious forms of nebulæ. The nebulous matter appears in festoons, apparently attached to some of the larger stars, such as Alcyone, Merope, and Maia, and in long, narrow, straight lines, the most remarkable of which, a faintly luminous thread starting midway between Maia and Alcyone and running eastward some 40', is beaded with seven or eight stars. The width of this strange nebulous streak is, on an average, 3" or 4", and there is, perhaps, no more wonderful phenomenon anywhere in celestial space. Unfortunately, no telescope is able to show it, and all our knowledge about it is based upon photographs. It might be supposed that it was a nebulous disk seen edgewise, but for the fact that at the largest star involved in its course it bends sharply about 10° out of its former direction, and for the additional fact that it seems to take its origin from a curved offshoot of the intricate nebulous mass surrounding Maia. Exactly at the point where this curve is transformed into a straight line shines a small star! In view of all the facts the idea does not seem to be very far-fetched that in the Pleiades we behold an assemblage of suns, large and small, formed by the gradual condensation of a nebula, and in which evolution has gone on far beyond the stage represented by the Orion nebula, where also a group of stars may be in process of formation out of nebulous matter. If we look a little farther along this line of development, we may perceive in such a stellar assemblage as the cluster in Hercules, a still later phase wherein all the originally scattered material has, perhaps, been absorbed into the starry nuclei.

The yellow star Sigma 430 has two companions: magnitudes six, nine, and nine and a half, distances 26", p. 55°, and 39", p. 302°. The star 30 of the fifth magnitude has a companion of the ninth magnitude, distance 9", p. 58°, colors emerald and purple, faint. An interesting variable, of the type of Algol, is lambda, which at maximum is of magnitude three and four tenths and at minimum of magnitude four and two tenths. Its period from one maximum to the next is about three days and twenty-three hours, but the actual changes occupy only about ten hours, and it loses light more swiftly than it regains it. A combination of red and blue is presented by Phi (mistakenly marked on map No. 23 as psi). The magnitudes are six and eight, distance 56", p. 242°. A double of similar magnitudes is chi, distance 19", p. 25°. Between the two stars which the naked eye sees in kappa is a minute pair, each of less than the eleventh magnitude, distance 5", p. 324°. Another naked-eye double is formed by theta^1 and theta^2, in the Hyades. The magnitudes are five and five and a half, distance about 5' 37".

The leading star of Taurus, Aldebaran (alpha), is celebrated for its reddish color. The precise hue is rather uncertain, but Aldebaran is not orange as Betelgeuse in Orion is, and no correct eye can for an instant confuse the colors of these two stars, although many persons seem to be unable to detect the very plain difference between them in this respect. Aldebaran has been called "rose-red," and it would be an interesting occupation for an amateur to determine, with the aid of some proper color scale, the precise hue of this star, and of the many other stars which exhibit chromatic idiosyncrasy. Aldebaran is further interesting as being a standard first-magnitude star. With the four-inch glass we see without difficulty the tenth-magnitude companion following Aldebaran at a distance of 114", p. 35°. There is an almost inexplicable charm about these faint attendants of bright stars, which is quite different from the interest attaching to a close and nearly equal pair. The impression of physical relationship is never lacking though it may be deceptive, and this awakens a lively appreciation of the vast differences of magnitude that exist among the different suns of space.

The actual size and might of this great red sun form an attractive subject for contemplation. As it appears to our eyes Aldebaran gives one twenty-five-thousand-millionth as much light as the sun, but if we were placed midway between them the star would outshine the sun in the ratio of not less than 160 to 1. And yet, gigantic as it is, Aldebaran is possibly a pygmy in comparison with Arcturus, whose possible dimensions were discussed in the chapter relating to Boötes. Although Aldebaran is known to possess several of the metallic elements that exist in the sun, its spectrum differs widely from the solar spectrum in some respects, and more closely resembles that of Arcturus.

Other interesting objects in Taurus are sigma, divisible with the naked eye, magnitudes five and five and a half, distance 7'; Sigma 674, double, magnitudes six and nine, distance 10.5", p. 147°; Sigma 716, double, magnitudes six and seven, distance 5", p. 200°--a pleasing sight; tau, triple, magnitudes four, ten and a half, and eleven, distances 36", p. 249°, and 36", p. 60°--the ten-and-a-half-magnitude star is itself double, as discovered by Burnham; star cluster No. 1030, not quite as broad as the moon, and containing some stars as large as the eleventh magnitude; and nebula No. 1157, the so-called "Crab nebula" of Lord Rosse, which our glasses will show only as a misty patch of faint light, although large telescopes reveal in it a very curious structure.

We now turn to the cluster of circumpolar constellations sometimes called the Royal Family, in allusion to the well-known story of the Ethiopian king Cepheus and his queen Cassiopeia, whose daughter Andromeda was exposed on the seashore to be devoured by a monster, but who was saved by the hero Perseus. All these mythologic personages are represented in the constellations that we are about to study.[4] We begin with Andromeda (map No. 24). The leading star alpha marks one corner of the great square of Pegasus. The first star of telescopic interest that we find in Andromeda is , a double difficult on account of the faintness of the smaller component. The magnitudes are four and eleven, distance 49", p. 110°. A few degrees north of the naked eye detects a glimmering point where lies the Great Nebula in Andromeda. This is indicated on the map by the number 116. With either of our three telescopes it is an interesting object, but of course it is advisable to use our largest glass in order to get as much light as possible. All that we can see is a long, shuttle-shaped nebulous object, having a brighter point near the center. Many stars are scattered over the field in its neighborhood, but the nebula itself, although its spectrum is peculiar in resembling that of a faint star, is evidently a gaseous or at any rate a meteoritic mass, since photographs show it to be composed of a series of imperfectly separated spirals surrounding a vast central condensation. This peculiarity of the Andromeda nebula, which is invisible with telescopes although conspicuous in the photographs, has, since its discovery a few years ago, given a great impetus to speculation concerning the transformation of nebulæ into stars and star clusters. No one can look at a good photograph of this wonderful phenomenon without noticing its resemblance to the ideal state of things which, according to the nebular hypothesis, must once have existed in the solar system. It is to be remembered, however, that there is probably sufficient material in the Andromeda nebula to make a system many times, perhaps hundreds or thousands of times, as extensive as that of which our sun is the center. If one contemplates this nebula only long enough to get a clear perception of the fact that creation was not ended when, according to the Mosaic history, God, having in six days finished "the heavens and the earth and all the host of them," rested from all his work, a good blow will have been dealt for the cause of truth. Systems far vaster than ours are now in the bud, and long before they have bloomed, ambitious man, who once dreamed that all these things were created to serve him, will probably have vanished with the extinguishment of the little star whose radiant energy made his life and his achievements briefly possible.

[4] For further details on this subject see Astronomy with an Opera-glass.

In August, 1885, a new star of magnitude six and a half made its appearance suddenly near the center of the Andromeda nebula. Within one year it had disappeared, having gradually dwindled until the great Washington telescope, then the largest in use, no longer showed it. That this was a phenomenon connected with the nebula is most probable, but just what occurred to produce it nobody knows. The observed appearances might have been produced by a collision, and no better hypothesis has yet been suggested to account for them.

Near the opposite end of the constellation from alpha we find the most interesting of triple stars in gamma. The two larger components of this beautiful star are of magnitudes three and six, distance 10", colors golden yellow and deep blue. The three-inch shows them finely. The smaller star is itself double, its companion being of magnitude eight, distance when discovered in 1842 0.5", color bluish green. A few years ago this third star got so close to its primary that it was invisible even with the highest powers of the great Lick telescope, but at present it is widening again. In October, 1893, I had the pleasure of looking at gamma Andromedæ with the Lick telescope, and at that time it was possible just to separate the third star. The angle seemed too small for certain measurement, but a single setting of the micrometer by Mr.

Barnard, to whose kindness I was indebted for my view of the star, gave 0.17" as the approximate distance. In 1900 the distance had increased to 0.4", p. 115°. The brilliance of color contrast between the two larger stars of gamma Andromedæ is hardly inferior to that exhibited in beta Cygni, so that this star may be regarded as one of the most picturesque of stellar objects for small telescopes.

Other pleasing objects in this constellation are the binary star 36, magnitudes six and six and a half, distance 1", p. 17°--the two stars are slowly closing and the five-inch glass is required to separate them: the richly colored variable R, which fades from magnitude five and a half to invisibility, and then recovers its light in a period of about four hundred and five days; and the bright star cluster 457, which covers a space about equal to the area of the full moon.

Just south of the eastern end of Andromeda is the small constellation Triangulum, or the Triangles, containing two interesting objects. One of these is the beautiful little double 6, magnitudes five and six, distance 3.8", p. 77°, colors yellow and blue; and the other, the nebula 352, which equals in extent the star cluster in Andromeda described above, but nevertheless appears very faint with our largest glass. Its faintness, however, is not an indication of insignificance, for to very powerful telescopes it exhibits a wonderful system of nuclei and spirals--another bit of chaos that is yielding by age-long steps to the influence of demiurgic forces.

A richer constellation than Andromeda, both for naked-eye and telescopic observation, is Perseus, which is especially remarkable for its star clusters. Two of these, 512 and 521, constitute the celebrated double cluster, sometimes called the Sword-hand of Perseus, and also chi Persei. To the smallest telescope this aggregation of stars, ranging in magnitude from six and a half to fourteen, and grouped about two neighboring centers, presents a marvelous appearance. As an educative object for those unaccustomed to celestial observations it may be compared among star clusters to beta Cygni among double stars, for the most indifferent spectator is struck with wonder in viewing it. All the other clusters in Perseus represented on the map are worth examining, although none of them calls for special mention, except perhaps 584, where we may distinguish at least a hundred separate stars within an area less than one quarter as expansive as the face of the moon.

Among the double stars of Perseus we note first eta, whose components are of magnitudes four and eight, distance 28", colors white and pale blue. The double epsilon is especially interesting on account of an alleged change of color from blue to red which the smaller star undergoes coincidently with a variation of brightness. The magnitudes are three and eight, distance 9", p. 9°. An interesting multiple is zeta, two of whose stars at least we can see. The magnitudes are three, nine, ten, and ten, distances 13", p. 207°, 90", and 112".

The chief attraction in Perseus is the changeful and wonderful beta, or Algol, the great typical star among the short-period variables. During the greater part of its period this star is of magnitude two and two tenths, but for a very short time, following a rapid loss of light, it remains at magnitude three and seven tenths. The difference, one magnitude and a half, corresponds to an actual difference in brightness in the ratio of 3.75 to 1. The entire loss of light during the declension occupies only four hours and a half. The star remains at its faintest for a few minutes only before a perceptible gain of light occurs, and the return to maximum is as rapid as was the preceding decline. The period from one minimum to the next is two days twenty hours forty-eight minutes fifty-three seconds, with an irregularity amounting to a few seconds in a year. The Arabs named the star Algol, or the Demon, on account of its eccentricity which did not escape their attention; and when Goodricke, in 1782, applied a scientific method of observation to it, the real cause of its variations was suggested by him, but his explanation failed of general acceptance until its truth was established by Prof. E. C. Pickering in 1880. This explanation gives us a wonderful insight into stellar constitution. According to it, Algol possesses a companion as large as the sun, but invisible, both because of its proximity to that star and because it yields no light, and revolving in a plane horizontal to our line of sight. The period of revolution is identical with the period of Algol's cycle of variation, and the diminution of light is caused by the interposition of the dark body as it sweeps along that part of its orbit lying between our point of view and the disk of Algol. In other words, once in every two days twenty hours and forty-nine minutes Algol, as seen from the earth, undergoes a partial eclipse.

In consequence of the great comparative mass of its dark companion, Algol itself moves in an orbit around their common center with a velocity quite sufficient to be detected by the shifting of the lines in its spectrum. By means of data thus obtained the mass, size, and distance apart of Algol and its singular comrade have been inferred. The diameter of Algol is believed to be about 1,125,000 miles, that of the dark body about 840,000 miles, and the mean distance from center to center 3,230,000 miles. The density of both the light and the dark star is slight compared with that of the sun, so that their combined mass is only two thirds as great as the sun's.

Mention has been made of a slight irregularity in Algol's period of variation. Basing his calculations upon this inequality, Dr. Chandler has put forward the hypothesis that there is another invisible body connected with Algol, and situated at a distance from it of about 1,800,000,000 miles, and that around this body, which is far more massive than the others, Algol and its companions revolve in a period of one hundred and thirty years! Dr. Chandler has earned the right to have his hypotheses regarded with respect, even when they are as extraordinary as that which has just been described. It needs no indulgence of the imagination to lend interest to Algol; the simple facts are sufficient. How did that bright star fall in with its black neighbors? Or were they created together?

Passing to the region covered by map No. 25, our eyes are caught by the curious figure, formed by the five brightest stars of the constellation Cassiopeia, somewhat resembling the letter W. Like Perseus, this is a rich constellation, both in star clusters and double stars. Among the latter we select as our first example sigma, in which we find a combination of color that is at once very unusual and very striking--green and blue. The magnitudes are five and seven, distance 3", p. 324°. Another beautiful colored double is eta, whose magnitudes are four and seven and a half, distance 5", p. 200°, colors white and purple. This is one of the comparatively small number of stars the measure of whose distance has been attempted, and a keen sense of the uncertainty of such measures is conveyed by the fact that authorities of apparently equal weight place eta Cassiopeiæ at such discordant distances as 124,000,000,000,000 miles, 70,000,000,000,000 miles, and 42,000,000,000,000 miles. It will be observed that the difference between the greatest and the least of these estimates is about double the entire distance given by the latter. The same thing is practically true of the various attempts to ascertain the distance of the other stars which have a perceptible parallax, even those which are evidently the nearest. In some cases the later measures increase the distance, in other cases they diminish it; in no case is there anything like a complete accord. Yet of course we are not to infer that it is hopeless to learn anything about the distances of the stars. With all their uncertainties and disagreements the few parallaxes we possess have laid a good foundation for a knowledge of the dimensions of at least the nearer parts of the universe.

We find an interesting triple in psi, the magnitudes of the larger components being four and a half and eight and a half, distance 30". The smaller star has a nine-and-a-half-magnitude companion, distance 3". A more beautiful triple is iota, magnitudes four, seven, and eight, distances 2", p. 256°, and 7.5", p. 112°. Cassiopeia contains many star clusters, three of which are indicated in the map. Of these 392 is perhaps the most interesting, as it includes stars of many magnitudes, among which are a red one of the eighth magnitude, and a ninth-magnitude double whose components are 8" apart. Not far from the star kappa we find the spot where the most brilliant temporary star on record made its appearance on November 11, 1572. Tycho Brahe studied this phenomenon during the entire period of its visibility, which lasted until March, 1574. It burst out suddenly with overpowering splendor, far outshining every fixed star, and even equaling Venus at her brightest. In a very short time it began to fade, regularly diminishing in brightness, and at the same time undergoing changes of color, ending in red, until it disappeared. It has never been seen since, and the suspicion once entertained that it was a variable with a period considerably exceeding three hundred years has not been confirmed. There is a tenth-magnitude star near the place given by Tycho as that occupied by the stranger. Many other faint stars are scattered about, however, and Tycho's measures were not sufficiently exact to enable us to identify the precise position of his star. If the phenomenon was due to a collision, no reappearance of the star is to be expected.

Camelopardalus is a very inconspicuous constellation, yet it furnishes considerable occupation for the telescope. Sigma 390, of magnitude five, has a companion of magnitude nine and a half, distance 15", 160°. Sigma 385, also of the fifth magnitude, has a ninth-magnitude companion, distance only 2.4", p. 160°. According to some observers, the larger star is yellow and the smaller white. The star 1 is a very pretty double, magnitudes both six, distance 10.4". Its neighbor 2 of magnitude six has an eighth-magnitude companion, distance 1.7", p. 278°. The star 7 of magnitude five is also double, the companion of magnitude eight being distant only 1.2". A glance at star cluster 940, which shows a slight central condensation, completes our work in Camelopardalus, and we turn to Ursa Major, represented in map No. 26. Here there are many interesting doubles and triples. Beginning with iota we find at once occupation for our largest glass. The magnitudes are three and ten, distance 10", p. 357°. In the double star 23 the magnitudes are four and nine, distance 23", p. 272°. A more pleasing object is sigma^2, a greenish fifth-magnitude star which has an eighth-magnitude companion, distance 2.6", p. 245°. A good double for our four-inch glass is xi, whose magnitudes are four and five, distance 1.87", p. 183°. This is a binary with a period of revolution of about sixty years, and is interesting as the first binary star whose orbit was determined. Savary calculated it in 1828. Near by is nu, a difficult double, magnitudes four and ten and a half, distance 7", p. 147°. In 57 we find again an easy double magnitudes six and eight, distance 5.5", p. 4°. Another similar double is 65, magnitudes six and eight, distance 3.9", p. 38°. A third star, magnitude seven, is seen at a distance of 114" from the primary.

We come now to Ursa Major's principal attraction zeta, frequently called Mizar. The naked eye perceives near it a smaller star, named Alcor. With the three-inch glass and a medium power we divide Mizar into two bright stars brilliantly contrasted in color, the larger being white and the smaller blue-green. Beside Alcor, several fainter stars are seen scattered over the field of view, and, taken all in all, there are very few equally beautiful sights in the starry heavens. The magnitudes of the double are three and four, distance 14.5", p. 148°. The large star is again double, although no telescope has been able to show it so, its duplicity being revealed, like that of beta Aurigæ, by the periodical splitting of the lines in its spectrum.

Ursa Major contains several nebulæ which may be glimpsed with telescopes of moderate dimensions. An interesting pair of these objects, both of which are included in one field of view, is formed by 1949 and 1950. The first named is the brighter of the two, its nucleus resembling a faint star. The nebula 2343 presents itself to us in the form of a faint, hazy star, but with large telescopes its appearance is very singular. According to a picture made by Lord Rosse, it bears no little resemblance to a skull, there being two symmetrically placed holes in it, each of which contains a star.

The portion of Canes Venatici, represented in map No. 26, contains two or three remarkable objects. Sigma 1606 is a close double, magnitudes six and seven, distance 1", p. 336°. It is a pretty sight with the five-inch. The double star 2 is singular in that its larger component is red and its smaller blue; magnitudes six and eight, distance 11.4", p. 260°. Still more beautiful is 12, commonly called Cor Caroli. This double is wide, and requires but a slight magnifying power. The magnitudes are three and six, distance 20", colors white or light yellow and blue. The nebula 3572, although we can see it only as a pair of misty specks, is in reality a very wonderful object. Lord Rosse's telescope has revealed in it a complicated spiral structure, recalling the photographs of the Andromeda nebula, and indicating that stupendous changes must be in process within it, although our records of observation are necessarily too brief to bring out any perceptible alteration of figure. It would seem that the astronomer has, of all men, the best reasons for complaining of the brevity of human life.

Lastly, we turn to Ursa Minor and the Pole Star. The latter is a celebrated double, not difficult, except with a telescope of less than three inches aperture in the hands of an inexperienced observer. The magnitudes are two and nine, distance 18.5". The small star has a dull blue color. In 1899 it was discovered by spectroscopic evidence that the Pole Star is triple. In pi' we see a wide double, magnitudes six and seven, distance 30", p. 83°.

This completes our survey of the starry heavens.