Philosophy 1103: Introduction to Philosophy of Science

Langara College
Department of Philosophy
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Problem Set 3

Total: 50 marks

Hand in answers to the following questions in class on Wednesday, Nov. 7.

1. Read the following passage, and answer the questions about it. (The passage may not be *entirely* accurate, as history.)

In 1615 Galileo was told by Cardinal Bellarmine that he could not "hold or defend" the Copernican hypothesis without "a true physical demonstration that the sun does not circle the earth but the earth circles the sun". Sometime after this, Galileo was on a ship carrying a huge tank of water. Galileo noticed that the motion of the ship caused the water in the tank to move. Also, once the water started moving, it tended to slosh back and forth with a fairly uniform frequency. Galileo became very excited. What are the tides, if not the earth's oceans sloshing back and forth with a regular frequency? And just as the tank's water could only be moved by the motion of the boat, so the oceans could only be moved by the earth's motion.

For this theory to work, the earth's motion must be non-uniform. It must speed up and slow down. But it does! The earth has two different motions: its rotation about its own axis, and its orbit around the sun. The speed of a point P on the earth's surface will result from these two motions being combined. When it is noon at P, the two motions are in opposite directions, so that the rotational speed of about 1000 km/h is subtracted from the orbital speed of about 100,000 km/h. At midnight, the two motions are added. Hence P is slowing down slightly all morning, and accelerating during the afternoon and evening. This acceleration is so gentle that we don't notice it directly, but it is enough, over time, to get the oceans moving back and forth, rising and falling several feet on some coastlines.

Galileo thus rejected the ancient theory of the astrologers, that the tides are due to the moon having some secret power over the oceans. It had long been known that one high tide each day occurs when the moon is at its highest point in the sky (the other high tide being 12 hours later, when the moon is directly under our feet). Also, the strongest tides ("spring tides") occur when the moon is full or new. During a half moon, the tides are at their weakest ("neap tides"). This lunar theory was

however accepted by Kepler, who held that the oceans were attracted to the moon, as well as to the earth. He wrote, "If the earth ceased to attract the waters of the sea, the seas would rise and flow into the moon..."

Concerning the lunar theory, Galileo wrote that:

> "Lately a certain prelate has published a little tract wherein he says that the moon, wandering through the sky, attracts and draws up toward itself a heap of water which goes along following it, so that the high sea is always in that part which lies under the moon. And since when the moon is below the horizon, this rising nevertheless returns, he tells us that he can say nothing to account for this effect except that the moon not only retains this faculty naturally in itself, but in this case has also the power to confer it upon the opposite sign of the zodiac."

Unfortunately for Galileo, his theory would also seem to naturally predict one high per day rather than two. (Galileo dismissed this anomaly as the result of additional factors, including the shape of the sea and its depth.) In addition to this criticism, however, Galileo also pointed out that the mechanism of the moon's supposed influence is completely unknown.

> "But that concept is completely repugnant to my mind; for seeing how this movement of the oceans is a local and sensible one, made in an immense bulk of water, I cannot bring myself to give credence to such causes as lights, warm temperatures, predominances of occult qualities, and similar idle imaginings."

Galileo also pointed out that the moon has no observable effect on a tank of water. The only way to get the water in a tank to slosh back and forth is by moving the tank.

(i) Summarise all the relevant *data* mentioned in the passage above, in point form. [3 marks]

(ii) Briefly describe the two *hypotheses* (Galileo's and the lunar theory) that were used to explain these data. [3 marks]

(iii) How plausible was each theory? (Point out any aspects that seem inherently plausible/implausible to you, or which would have seemed plausible/implausible in the early 17th century.) [3 marks]

(iv) How well did each theory predict the data, overall? Explain your answers. [3 marks]

(v) Given only the knowledge available at the time, which hypothesis was the better explanation of the total data, in your view? Briefly explain your answer. [3 marks]

2. Read the following passage (from Darwin, *The Origin of Species*, Ch. 11) and then answer the questions about it.

The most striking and important fact for us in regard to the inhabitants of islands, is their affinity to those of the nearest mainland, without being actually the same species. Numerous instances could be given of this fact. I will give only one, that of the Galapagos Archipelago, situated under the equator, between 500 and 600 miles from the shores of South America. Here almost every product of the land and water bears the unmistakeable stamp of the American continent. There are twenty-six land birds, and twenty-five of those are ranked by Mr. Gould as distinct species, supposed to have been created here; yet the close affinity of most of these birds to American species in every character, in their habits, gestures, and tones of voice, was manifest. So it is with the other animals, and with nearly all the plants, as shown by Dr. Hooker in his admirable memoir on the Flora of this archipelago. The naturalist, looking at the inhabitants of these volcanic islands in the Pacific, distant several hundred miles from the continent, yet feels that he is standing on American land.

Why should this be so? why should the species which are supposed to have been created in the Galapagos Archipelago, and nowhere else, bear so plain a stamp of affinity to those created in America? There is nothing in the conditions of life, in the geological nature of the islands, in their height or climate, or in the proportions in which the several classes are associated together, which resembles closely the conditions of the South American coast: in fact there is a considerable dissimilarity in all these respects.

On the other hand, there is a considerable degree of resemblance in the volcanic nature of the soil, in climate, height, and size of the islands, between the Galapagos and Cape de Verde Archipelagos: but what an entire and absolute difference in their inhabitants! The inhabitants of the Cape de Verde Islands are related to those of Africa, like those of the Galapagos to America. I believe this grand fact can receive no sort of explanation on the ordinary view of independent creation; whereas on the view here maintained, it is obvious that the Galapagos Islands would be likely to receive colonists, whether by occasional means of transport or by formerly continuous land, from America; and the Cape de Verde Islands from Africa; and that such colonists would be liable to modifications; the principle of inheritance still betraying their original birthplace.

(i) Briefly summarise the creationist hypothesis that Darwin opposes in this passage. [3 marks]

(ii) What data does Darwin appeal to in the passage? (Summarised, in point form) [3 marks]

(iii) What does the creationist hypothesis predict, according to Darwin, about the inhabitants of the Galapagos, the South American mainland, the Cape Verde islands, and the African mainland? [3 marks]

(iv) What does Darwin's theory predict, concerning the inhabitants of these four regions? [3 marks]

(v) Considering the 'prior plausibility' (or prior probability) of each theory, given the worldview of people at the time, as well as the empirical adequacy of each theory, which hypothesis is the best explanation of the data? [3 marks]

[In considering this question of plausibility, you should be aware that, while creationist beliefs about God's design of the natural world were still powerful, so too were desires to bring biology into line with other sciences. In astronomy, physics, chemistry, geology, etc., everything is explained in terms of universal natural laws, rather than direct divine action, and pressure was building to extend this method to biology. For example, biologist Thomas Henry Huxley lamented in 1860, "Shall Biology alone remain out of harmony with her sister sciences?"]

3. (i) According to Thomas Kuhn, how does a scientific community restrict the scientific ideas that a researcher can investigate? (You may refer the duck-rabbit story that I told near the start of the course.) [3 marks]

(ii) According to Michael Polanyi, why is *necessary* for a scientific community to restrict science to 'orthodox' viewpoints, and allow only a very limited range of dissent? [3 marks]

(iii) What does it mean for journal editors or referees to act as 'gatekeepers'? [3 marks]

(iv) Does Sydney Brenner agree with Polanyi's view on the need to enforce orthodoxy? Explain Brenner's reasons for his view. [3 marks]

(v) What is *your* view about the proper role of authority in a scientific community? For example, do you side with either Polanyi or Brenner? Give your reasons. [3 marks]

4. Most people think of scientific investigation as yielding a special kind of understanding, being perhaps more objective, rigorous or disciplined than other methods. Yet there is disagreement about what exactly makes science so special.

(i) According to Karl Popper, what feature of science separates it from the methods of astrology, Marxist economics, or psychoanalysis? [2 marks]

(ii) Briefly state 3 objections, in one sentence each, to Popper's 'criterion of demarcation' described in part (i). [3 marks]