A NOTE ON THE ARISTOTELIAN ORIGIN OF POPPER'S DEMARCATION CRITERION TOGETHER WITH ITS APPLICATION TO ATLANTIC CANADA'S FISHERIES

Christopher J. Corkett*

*Christopher is a retired Instructor from the Biology Department of Dalhousie University. He is currently applying Karl Popper's non-inductive theory of method to the management of the world's commercial fisheries.

Abstract

It has not always been realised that Karl Popper's demarcation criterion, the criterion he uses to distinguish an empirical science from its 'metaphysical' complement involves an interpretation of the classical theory of terms. From the beginning Popper's criterion never was an attempt to distinguish some subject matter called 'science' from some subject matter called 'metaphysics'. His criterion of falsifiability always was an attempt to distinguish the logical strength of a universal law from the logical weakness of its complement, a complement that can bear no fruit. For example: if the falsifiability criterion is applied to the management of the fisheries of Atlantic Canada we can distinguish the bold and sound management of Atlantic lobster from the weak and unsound management of Atlantic groundfish. In the early 1990s Newfoundland's fishery for Atlantic cod suffered a major collapse that has become one of the world's most prominent case studies of failure in fisheries management. Under Popper's analytic theory of demarcation a weak management with no problem solving potentiality is to be held responsible for the collapse of Newfoundland's Atlantic cod fishery.

1. Introduction

Logic is one of the most ancient of all disciplines. It was founded by the Greek scientist and philosopher Aristotle (384-322 B.C.) before even the Hellenistic development of mathematics. (1) This classical logic is of particular interest for its theory of the categorical syllogism and the theory of terms. In the theory of terms every term has a complementary term or complement for short. The complement is a general term embracing everything to which the original term is not applicable. (2) For example: the complement of the term 'pencil' is 'thing other than pencil' or simply 'non-pencil'. In these notes we take an interest in two complements: 'contingent truth' (also referred to as a 'truths of fact') as a complement of the *necessary truth* of mathematics and logic (Table 1A) and 'metaphysics' as a complement of the *necessary falsity* of empirical science (Table 1B).

Table 1 Two interpretations of the theory of terms: (A) a necessary truth with its complement 'contingent truth' and (B) a necessary falsity with its complement 'metaphysics'.

	Original term	**Complementary term**
A	Mathematics and logic as a necessary truth	'contingent truth' $^{\alpha}$
B	Empirical science as a necessary falsity	'metaphysics' $^{\beta}$

$^{\alpha}$ 'contingent truth' embraces everything to which the term necessary truth does not apply

$^{\beta}$ 'metaphysics' embraces everything to which the term necessary falsity does not apply

2. Necessary truth

Mathematical truths and the laws of the sentential calculus are the very paradigm of necessary truth. (3). Under the theory of terms we can distinguish between a mathematics and logic characterised by necessary truth and its complement; a 'contingent truth' that

includes, but is not limited to, the facts and laws of science (Table 1A). We can illustrate a necessary truth by the validity of a simple deductive inference. For example:

If 'all swans are white' (All S is P) is true then 'black swans do not exist' (No S is non-P) is true (A)

Proposition (A) is a sound argument that is necessarily true since every conceivable situation that makes 'All swans are white' true also makes 'Black swans do not exist' true. That is 'All S is P' entails its obverse 'No S is non-P' (4) which is the same as saying 'Black swans do not exist' is a valid deductive consequence of 'All swans are white'.

3. Necessary falsity

Karl Popper interprets the theory of terms as a demarcation criterion that distinguishes between an empirical science in the form of a necessary falsity and the complement to a necessary falsity referred to as 'metaphysics', a complement that includes, but is not limited to, mathematics and logic (Table 1B). We can illustrate a necessary falsity by the validity of the following falsifying inferences:

If 'Here is a black swan' is true then 'Black swans do not exist' is false (B)

If 'Black swans do not exist' is false then 'All swans are white' is false (C)

Propositions (B) and (C) combine to form The Law of the Retransmission of Falsity. This deductive law is a necessary falsity since it retransfers falsity without any conceivable exception; that is every situation that makes 'Black swans do not exist' false also makes 'All swans are white' false. Of course we may have made a mistake in accepting 'Here is a

black swan' as true in (B). However in no way whatever does this mistake diminish the validity of the law. (5)

4. Popper's novel language

Propositions (A) to (C) are given in a linguistic form that has often been the subject of ridicule. Martin Gardner (6) for example, states:

> I believe that Popper's reputation was based mainly on his persistent but misguided efforts to restate common sense views in a novel language that is rapidly becoming out of fashion .

However the force and intent of Popper's novel language become evident when one realises that black and white swans are proxies for the subject (S) (as swans) and predicate (P) (as black and white) of Aristotle's categorical propositions (Table 2).

Table 2 Aristotle's particular and universal categorical propositions

Particular proposition	'Some S is P'	'Some swans (S) are white (P)'
Universal proposition	'All S is P'	'All swans (S) are white (P)'
Obverse form of a universal proposition	'No S is non-P'	'No swans (No S) are non-white (non-P) or 'Black swans do not exist'

We are particularly interested in the Aristotelian distinction between 'Some S is P' and 'All S is P' with respect to what is referred to as their existential import. The term 'some' as in 'Some swans are white' implicitly assumes at least one swan actually exists. 'Some swans are white' can be given as the existential proposition 'At least one white swan exists' (Table 3). By contrast the term 'all' as in 'All swans are white' means 'all that there are' as in 'all swans that there are, are white.' (7) There is no assumption that swans exist, that is there is no assumption of existential import. The universal categorical proposition or universal law 'All swans are white' can be given as the non-existence proposition 'Black swans do not exist' (Table 3).

Table 3 Popper's demarcation between an existential hypothesis (At least one white swan exists) that cannot be falsified and a falsifiable universal law (All swans are white) in its non-existential form (Black swans do not exist).

Aristotle's demarcation [α]	Popper's demarcation [β]
Particular categorical proposition 'Some swans are white'	Non-falsifiable existential proposition 'At least one white swan exists'
Universal categorical proposition 'All swans are white'	Falsifiable non-existence proposition 'Black swans do not exist'

[α] Aristotle's demarcation is based on the presence (Some swans are white) or absence (All swans are white) of existential import

[β] Popper's demarcation is based on absence (At least one white swan exists) or the presence (Black swans do not exist) of falsifiability

5. Logical and empirical content

It is important to distinguish between two ways in which the information content of a theory can be logically expressed: (8)

●The *logical content* of a mathematics and logic (Table 1A) is the set or class of all propositions that can be logically derived from a theory. This information content is sometimes expressed as 'what follows from what' and can be illustrated in a rough intuitive way by a set or class. For example: if the letter 'P' denotes the set or class of prime numbers and the symbol 'ϵ' stands for the phrase 'is a member or element of', then the proposition

'$7 \epsilon P$'

means that seven is a member of the set of prime numbers - in other words, that seven is a prime number. (9) We can say the logical content of a mathematical or logical theory is the class of its consequences. In our simple example the set of prime numbers has as its consequent class all the numbers (elements) that belong to P.

●The *empirical content* of an empirical science (Table 1B) is the set or class of those empirical propositions that are excluded by a theory. For example: the theory 'There are no black swans' rules out the empirical observation 'Here is a black swan', an observation that may be described as a possible falsification or potential falsifier of the theory in question. (10) If such a possible falsification is actually observed then the theory is empirically falsified.

6. Asymmetry of logical strength

Table 3 involves an asymmetry of logical strength that results from a well-known syllogistic fact: 'All swans are white' is capable of entailing 'Some swans are white' but the reverse is not the case. There are no conditions under which 'Some swans are white' can

entail 'All swans are white.' (11) From this it follows: a universal categorical proposition or universal law (All swans are white) is logically stronger than a particular categorical proposition or existential hypothesis ('Some swans are white' or 'At least one white swan exists', Table 3). The logical weakness of an existential hypothesis can be illustrated in a simple way: The hypothesis 'At least one mermaid exists' is verifiable in principle since we can easily imagine conditions under which a mermaid would be found. However this assertion cannot be falsified by failing to find a mermaid. This is because we can always visualize a mermaid as being out there somewhere, one that has not yet been found. This simple demonstration of logical weakness in the form of non-falsifiability is another way of saying an existential hypothesis *that has no empirical content* is logically weaker than a universal law *that has empirical content* (see section 5).

7. Problem solving

Difficult theoretical and practical problems can only be solved by bold theories; that is theories and policies with high logical and empirical content (see section 5). Mathematical truths such as '2 + 2 = 4' and scientific models based on data are not bold. They have no problem solving capability. For example: the fisheries models and policies used to manage Atlantic Canada's cod fisheries go as little beyond the data as possible. Their logical content is certainly high but their empirical content is nil. They do not possess the potentiality necessary to solve the problems that face a fisheries manager. Unlike Atlantic Canada's cod fisheries, the fisheries for Atlantic lobster are managed by bold policies with problem solving potential. (12) We can represent this problem solving potential in the form of a falsifying schema (13) that upholds the Law of the Retransfer of Falsity (see section 3), as:

$$P_1 \rightarrow TD \rightarrow EE \rightarrow P_2 \rightarrow TD \rightarrow EE \ldots \text{etc.} \qquad (D)$$

where P_1 = the initial problems including the goal to be pursued; TD = tentative decision, a bold policy that reflects the chosen goal; EE = error elimination, objective feedback by

which the effectiveness of the policy is assessed and P_2 = the new problems and consequences that arises as the result of the decision taken.

8. The collapse of Newfoundland's Atlantic cod fishery

Scientists have always understood the importance of distinguishing sound and rational decisions from unsound ones. However, the assumption has always been that further scientific study will eventually lead to a natural understanding of rationality - a methodological position known as naturalism. (14) Karl Popper's analytic theory of demarcation stands in sharp contrast to naturalism. For example: if Popper's falsifiability criterion is applied to the management of the commercial fisheries of Atlantic Canada we can make an analytic distinction between:

- The bold management of Atlantic lobster in which problems have the potential to be solved by the necessary falsity (Table 1B) of schema (D) and
- The data-based management of Atlantic groundfish (15) in which a 'metaphysical' complement to a necessary falsity (Table 1B) has no problem solving potentiality. (16)

Newfoundland's fishery for Atlantic cod was once the largest cod fishery in the world. (17) In the early 1990s this fishery suffered a major collapse that has become one of the world's most prominent case studies of failure in fisheries management. (18) Under an analytic and falsifiable view of fisheries science, a weak management with no problem solving potentiality is to be held responsible for the collapse of Newfoundland's Atlantic cod fishery.

9. Conclusion as perspective

Karl Popper's falsifiable interpretation of the classical theory of terms never was an attempt to separate some subject matter called 'science' from some subject matter called

'metaphysics'. His demarcation criterion of falsifiability always was an attempt to distinguish between the logical strength of a universal law as a necessary falsity and the complement to a necessary falsity as a 'metaphysics' that can bear no fruit.

NOTES AND REFERENCES

1. The first substantive mathematical writings are those of the Greek mathematician Euclid around 310 BC. See, Luke Hodgkin, *A History of Mathematics from Mesopotamia to Modernity* (Oxford, University Press, 2005), 40.

2. Nicholas Rescher, *Introduction to Logic* (New York: St Martin's Press, 1964), 24.

3. Benson Mates, *Elementary Logic*, Second Edition (New York: Oxford University Press, 1972), 9.

4. Rescher, *Introduction*, 133.

5. Christopher Corkett, "Karl Popper's definition of science", *Fisheries. Research*, 96 (2009): 323.

6. Martin Gardner, "A skeptical look at Karl Popper". *The Skeptical Enquirer*, 25 (2001): 13-14; 72.

7. Rescher, *Introduction*, 115.

8. Karl R. Popper, "The Logic and Evolution of Scientific Theory," in *All Life is Problem Solving*. (London: Routledge, 1999), 19.

9. Mates, *Elementary*, 33.

10. Corkett, "Popper's definition", 323.

11. Rescher, *Introduction*, 131

12. Christopher J. Corkett, "Can we stop the Atlantic lobster fishery going the way of Newfoundland's Atlantic cod? A perspective," *Proceeds of the Nova Scotian Institute of Science*, 46 (2011): 139-147.

13 Karl R. Popper, "Epistemology Without a Knowing Subject," in *Objective Knowledge: An Evolutionary Approach*, Revised Edition (Oxford: Clarendon Press, 1979), 144.

14. Karl R. Popper, *The Logic of Scientific Discovery* (London: Hutchinson, Revised Edition, 1968), Section 10, 50-53.

15. Groundfish are a group of commercially important fishes such as cod, haddock, pollack and flounder that live on the sea bottom.

16. Corkett, "Newfoundland's Atlantic cod",

17. Patrick T. McGrath, *Newfoundland in 1911, Being the Coronation Year of King George V and The Opening of the Second Decade of the Twentieth Century* (London: Whitehead, Morris, 1911), 128.

18. Anthony T. Charles, "Fisheries Management in Atlantic Canada," *Ocean and Coastal Management,* 35 (1997):101-119.