

TRENDS IN THE NOMENCLATURE OF PASTEURELLAE ASSOCIATED WITH VARIOUS DISEASES IN CATTLE

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SUMMARY

Pasteurella multocida and *P. haemolytica* have been associated with various diseases of cattle for many years. Following the first isolation of *P. multocida* by Pasteur in 1880 many names were subsequently used to describe this organism resulting into a lot of confusion. The latter became more apparent following the recognition that the species exists in many serotypes. Different workers developed different systems for designating the serotypes. However, Carter - Heddlestone's method proved to be more popular than those by other workers. It has been recommended that Carter - Heddlestone's method be adopted universally to avoid the use of different designations in identifying the same serological varieties and to simplify the interpretation of available literature on pasteurellosis. Unlike *P. multocida*, subsequent to the first isolation of *P. haemolytica* by Nocard in 1892, only a few names were used for describing the organism. Although the species does exist in many serotypes, only the system developed by Biberstein and co-workers has been adopted worldwide for designating the different serotypes.

INTRODUCTION

The genus *Pasteurella* consists of six species (*P. aerogenes*, *P. gallinarum*, *P. haemolytica*, *P. multocida*, *P. pneumotropica* and *P. ureae*) two of which (*P. haemolytica* and *P. multocida*) are important pathogens of cattle (Carter, 1986). Disease of cattle associated with the latter species have been recognized for many years (Kinsley 1915; Hepburn 1925; Shoo 1989).

Following the first isolation of bipolar staining organisms from cases of bovine haemorrhagic septicaemia in 1880 by Pasteur (cited by Hussaini, 1975) and bovine pneumonia (Nocard, 1892),

nomenclature of *Pasteurella spp* associated with diseases in cattle has undergone many changes some of which have been confusing (Hussaini, 1975; Carter and Chengeppa, 1981). The objective of this work was to review the nomenclature of *P. multocida* and *P. haemolytica* emphasizing on first, the names which gained widespread recognition - second, the currently recommended means of designating the various serotypes and lastly, to present the specific serotypes involved in bovine diseases.

NOMENCLATURE OF PASTEURELLA MULTOCIDA AND PASTEURELLA HAEMOLYTICA

Pasteurella multocida

In 1877, Chabert investigated outbreaks of fowl cholera in France (Rhoades and Rimler, 1984) and in the following year, Bollinger described

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outbreaks of bovine haemorrhagic septicaemia in Germany for the first time (Ingram and Hoare, 1913). Pasteur isolated the causal agent from these conditions in 1880 and were designated as *Bacterium bipolare multocidum* by Kitt in 1885 (Hussaini, 1975). The epithet "bipolare" was chosen on account of the deeper staining areas at the poles of these organisms and "multocidum" was used to emphasise their multi-host character (Hussaini, 1975). In 1895, Flügge changed the name to *Bacillus bovissepticus* but a year later, Irevisari proposed the generic name *Pasteurella* in recognition of Pasteur's original work (Hussaini, 1975). Subsequently, the generic names *Pasteurella* and *Bacillus* were used synonymously (Carter, 1967; Hussaini, 1975; Rehmtulla and Thomson, 1981).

In 1901, Lignieres suggested a "zoological classification" on the presumed existence of "formae speciales" and named the strains isolated from cattle and pigs as "La *Pasteurella* bovine" and "La *Pasteurella* porcine", respectively (Hussaini, 1975). This led to the use of specific epithets such as "bovisseptica", "suisseptica", "avisseptica" to identify the host species from which the organisms had been isolated. Topley and Wilson (1929) considered such nomenclature to be arbitrary. They believed that the organism belonged to the same species and they suggested the epithet "septica" for all of them. Subsequently, the name *Pasteurella septica* gained widespread acceptance in Britain and the Commonwealth countries (Carter, 1967). Later Rosenbusch and Merchant (1939) studied 114 strains of *Pasteurella* and suggested another species name, *Pasteurella multocida* for this organism. Since then, this name has become the universally accepted one (Carter 1967).

Cornellius (1929) showed that the species existed in four different groups on the basis of agglutination - absorption method. This heterogeneity of the species was later confirmed by Roberts (1947) who classified the species into types I, II, III and IV using serum protection test in mice. The workers also observed that there were strains which could not be classified into any of these four groups. Later, Carter (1955, 1961) demonstrated the existence of five capsular types of *P. multocida* using passive haemagglutination test. These were designated as A, B, C, D and E. It was then observed that A, B, C and D corresponded to types II, I, III and IV of Robert's respectively (Carter, 1955). Type E strains which were obtained from cases of haemorrhagic septicaemia in Africa (Carter, 1961) corresponded to none of Robert's types. Carter (1963) further noticed that type C was not a distinct capsular type like the other ones and it proved to be difficult to recognize. This capsular type was dropped out leaving only types A, B, D and E (Carter, 1963). In line with Carter's capsular typing, a serological method which involved the identification of somatic antigens using hydrochloric acid-treated bacteria and agglutination - absorption was developed by Namioka and co-workers (Namioka and Murata, 1961; 1964; Namioka and Bruner, 1963). The workers identified 14 serotypes and labelled them according to the specific somatic component (a number) and the capsular type (a capital letter), for example, 1:A, 9:B, 6:E, etc. (Table 1). This method failed to get practical application because it is "involved and laborious" (Carter and Chengeppa, 1981). Another serotyping procedure involving gel diffusion precipitin method was developed by Heddleston et al. (1972) who identified 16 serological types of *P. multocida*. Carter and Chengeppa (1981) commented that Heddlestons'

method was simple to carry out and consequently it achieved considerable popularity. At the same time, Carter and Chengeppa (1981) considered the time was appropriate to standardize the methods of designating serotypes of *P. multocida* in order to avoid the use of different designations in identifying the same serological varieties and to simplify the interpretation of the available literature relating to pasteurellosis. They recommended that strains of *P. multocida* be identified as serotypes represented by both Carter's capsular and Heddlestone's serological types, for example, B:2, E:2, etc. (Table 2). Carter (1984) commented that there might be more than these 16 serological varieties.

Pasteurella haemolytica

Nocard (1892) isolated "bipolar staining organisms" often in pure culture from pneumonic tissues obtained from cattle imported from North America to France. Jones (1921) used cultural and agglutination procedures and found that bipolar staining organisms obtained from similar pneumonic cases in North America were classifiable into three groups designated as *Bacillus bovisepiticus* Groups, I, II and III respectively. Later Newsome and Cross (1932) proposed the name *Pasteurella haemolytica* for the organisms with properties similar to *Bacillus bovisepiticus* Jones Group I

Table 1: Designation of serotypes of *Pasteurella multocida* according to Namioka's method*

Capsular type	Somatic component (O - group)	Serotype
A	1	1:A
	3	3:A
	5	5:A
	7	7:A
	8	8:A
B	9	9:A
	6	6:B
	11	11:B
D	1	1:D
	2	2:D
	3	3:D
	4	4:D
E	10	10:D
	8	6:E

*After: Namioka (1978).

and since that time this species name has been widely accepted (Carter, 1967). The organisms belonging to

either Groups II or III Jones's classification were found to be *P. multocida* (Carter, 1967).

Table 2: Designation of serotypes of *Pasteurella multocida* according to Carter - Heddleston's method*

Capsular type	Somatictype	Serotype	
A	1	A:1	
	3	A:3	
	4	A:4	
	6	A:6	
	7	A:7	
	8	A:8	
	9	A:9	
	10	A:10	
	12	A:12	
	13	A:13	
	14	A:14	
	15	A:15	
	16	A:16	
	B	2	B:2
	D	11	D:11
	E	2	E:2

*After: Carter and Chengeppa (1981).

Smith; 1961) used cultural and biochemical properties and found that *P. haemolytica* could be divided into two biotypes, A and T. Biotype A - strains fermented arabinose but not trehalose. The reverse applied to biotype T - strains. Various workers (Biberstein et al., 1960; Biberstein and Gills, 1962; Biberstein and Thompson, 1966; Pegram et al., 1979, Fraser et al., 1982; Fodor et al., 1988) studied many strains of *P. haemolytica* from cattle and other animals using indirect haemagglutination (IHA) test and identified a total of 16 serotypes. The latter were labelled according to the biotype letter (A or T) followed by a number e.g. A1, A2, T10 etc (Table 3). Although 16 serotypes have been identified, untypable strains also do exist (Donachie et al., 1984., Shoo, 1986; 1990) (Table 3).

SEROTYPES OF PASTEURELLAE INVOLVED IN BOVINE DISEASES

Pneumonic Pasteurellosis

Bovine pneumonic pasteurellosis (shipping/transit fever) is a disease of great economic importance in beef cattle in North America (Yates, 1982) and Britain (Selman et al., 1986). The clinical and pathological features of this condition have been attributed to infection with *Pasteurellae* (Rehmtulla and Thomson, 1981).

P. haemolytica A1 has been encountered most often and apparently the only one associated with epidemic pneumonia in cattle (Biberstein, 1978). This serotype accounts for up to 90% of all incidents of pasteurella-pneumonia in cattle (Reggiardo, 1987

Table 3: Designation of serotypes of *Pasteurella haemolytica*

Biotype	"Serotype"	Designation
	1	A1
	2	A2
A	5	A5
	6	A6
	7	A7
	8	A8
	9	A9
	11	A11
	12	A12
	13	A13
	14	A14
	16	A16
T	3	T3
	4	T4
	10	T10
	15	T15

*After: Biberstein (1978); Pegram et al. (1979); Fraser et al. (1982); Fodor et al. (1988).

Allan et al. (1985). Others include serotypes A₁, A₆, T₁₀ and *P. multocida* (Allan et al., 1985; Shoo, 1990).

Haemorrhagic septicaemia

When bovine haemorrhagic septicaemia was first described in Germany by Bollinger in 1878 (Ingram and Hoare, 1913), it was thought to occur worldwide but at present time it is diagnosed only in parts of Africa, Asia and in small areas of Southern Europe (De Alwis, 1984).

The disease in Asia is caused by *P. multocida* serotype B:2 and in Africa by both B:2 and E:2 (De Alwis, 1984).

Mastitis

Bovine mastitis due to *P. multocida* (Lovell, 1939, Burton and Emslie, 1942; Tucker, 1953; Barnum, 1954;

Pepper et al., 1968; Chakraborty et al.; 1978) and *P. haemolytica* (Maplesden and Carter, (1955) have been described. None of these species were serotyped by the workers.

Abortion

Recently, *P. haemolytica* A₁, A₆, T₁₀, untyped strain of the species (Neill et al., 1981; Messier et al., 1981; Ward et al., 1985) and untyped *P. multocida* (Ward et al., 1985) have been identified as one of the causes of abortion and infections of the female genital tracts of cattle in North America and Northern Ireland.

Meningoencephalitis

Meningoencephalitis due to untyped *P. multocida* has been reported in Britain (Shand and Markson, 1953) and Australia (Rose and Rac, 1957). Since these reports would appear to be the

only available information on this condition, it can be deduced that meningoencephalitis in cattle caused by *Pasteurellae* is uncommon.

DISCUSSION

It is evident from this review that nomenclature of *P. multocida* unlike that of *P. haemolytica* has been surrounded by considerable confusion. There are several current examples to illustrate this further. In published reports from Africa and Asia (Namioka, 1978; Shigidi and Mustafa, 1979; De Alwis, 1984), the system of Namioka has been used in designating serotypes of *P. multocida* isolated from cattle and other animals. In Britain and North America on the other hand, Carter - Heddlestone's system has been used for that purpose (Curtis and Ollernhead, 1978; Carter and Chengeppa, 1981; Carter 1984).

It was also apparent that Namioka's and Carter - Heddlestone's systems of designating serotypes of *P. multocida* are very different. For example, the serotypes of *P. multocida* involved in haemorrhagic septicaemia are 6:B and 6:E according to Namioka's system but B:2 and E:2 according to Carter - Heddlestone's system. Furthermore, as also apparent in Tables I and II, there have been more serotypes indentified under capsular types B and D and much fewer under type A in Namioka's classification than under Carter - Heddlestone's.

The above examples further stress the opinion of Carter and Chengeppa (1981) that it is time that the methods of identifying serotypes of *P. multocida* were standardized in order to avoid the use of different designations in identifying the same serological varieties and to simplify the interpretation of the available literature on pasteurellosis. The

system developed by Carter and Heddlestone should be universally adopted in view of its popularity compared to that by Namioka.

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REFERENCES

- Allan, E.M., Wiseman, A., Gibbs, H.A., and Selman, I.E. (1985). *Pasteurella* species isolated from the bovine respiratory tract and their antimicrobial sensitivity patterns. *Vet. Rec.* 117:629-631.
- Barnum, D.A. (1954). A herd outbreak of mastitis caused by *Pasteurella multocida*. *Can. J. Comp. Med.* 18:113-119.
- Biberstein, E.L., Gills, M.G. and Knight, H. (1960) Serological types of *Pasteurella haemolytica*. *Cornell Vet.* 50:283-300.
- Biberstein, E.L. and Gills, M.G. (1962). The relation of the antigenic types to the A and T types of *Pasteurella haemolytica*. *J. Comp. Path.* 72:316-320.
- Biberstein, E.L. and Thompson, D.A. (1966). Epidemiological studies of *Pasteurella haemolytica* in sheep. *J. Comp. Path.* 76:83-94.

Siberstein, E.L. (1978). Biotyping and serotyping *Pasteurella haemolytica*. In: T. Bergan and J.R. Norris (Editors). Methods in Microbiology, Vol.10 Academic Press, London/New York/San Francisco 253-269.

Burton, I.W. and Enslie, J.W. (1942). Infection of the bovine udder caused by *Pasteurella septica*. Vet. Rec. 24:387-388.

Carter, G.R. (1955). Studies on *Pasteurella multocida*. A haemagglutination test for the identification of serological types. Am. J. Vet. Res. 20:481-484.

Carter, G.R. (1961). A new serological type of *Pasteurella multocida* from Central Africa. Vet. Rec. 72:1052.

Carter, G.R. (1963). Proposed modification of the serological classification of *Pasteurella multocida*. Vet. Rec. 75:1264-1265.

Carter, G.R. (1961). Pasteurellosis. *Pasteurella multocida* and *Pasteurella haemolytica*. Adv. Vet. Sc. 11:321-379.

Carter, G.R. and Chengeppa, M.M. (1981). Recommendation for a standard system of designating serotypes of *Pasteurella multocida*. Proc. Am. Assoc. Vet. Lab. Diagn. 24:37-42.

Carter, G.R. (1984). Genus *Pasteurella*. In: Bergey's Manual of Determinative bacteriology, Vol. 1 Williams and Wilkins, Baltimore/London. 552-558.

Chakraborty, A.K., Sarmah, A.K. and Boro, B.R. (1978). A case of clinical mastitis due to *Pasteurella multocida*. Vet. Rec. 103:313.

Conradius, J.T. (1929). An investigation of the serological relationships of twenty six strains of *Pasteurella*. J. Path. Bacteriol. 32:355-364.

Curtis, P.E. and Ollerhead, G.E. (1978). *Pasteurella multocida* infection of broiler chickens. Vet. Rec. 103:312-313.

De Alwis, M.C.L. (1984). Haemorrhagic septicaemia in cattle and buffaloes. Res. Sri. Tech. Off. Int. Epiz. 3:707-730.

Donachie, W., Fraser, J., Quirie, M. and Gilmour, N.J.L. (1984). Studies on strains of *Pasteurella haemolytica* not typable by indirect haemagglutination test. Res. Vet. Sc. 37:188-193.

Fraser, J. Laird, S. and Gilmour, N.J.L. (1982). A new serotype (biotype T) of *Pasteurella haemolytica*. Res. Vet. Sc. 32:127-128.

Fodor, L., Varga, J., Hajtas, J. Donachie, W. and Gilmour, N.J.L. (1988). Characterisation of a new serotype of *P. haemolytica* isolated in Hungary. Res. Vet. Sc. 44:329.

Heddleston, K.L., Gallagher, J.E. and Reber, P.A. (1972). Fowl cholera. Gel diffusion precipitin test for serotyping *Pasteurella multocida* from avian species. Avian Dis. 16:925-936.

- Hepburn, W. (1925). A clinical survey of "Transit Fever" in bovines. *Vet. Rec.* 5:201-208.
- Hussaini, S.N. (1975). Nomenclature and taxonomy of *Pasteurella multocida*. *Vet. Bull.* 45:403-409.
- Ingram, G.L. and Hoare, E.W. (1913). The haemorrhagic septicaemia. In: A system of Veterinary Medicine Vol.1, Ed. E.M. Hoare. Bailliere, Tindal and Cox.
- Jones, F.S. 1921. A study of *Bacillus bovisepiticus*. *J. Exp. Med.* 34:561-577.
- Kinsley, A.T. (1915). Haemorrhagic septicaemia. *J. Am. Vet. Med. Assoc.* 48:49-52.
- Lovell, R. (1939). The isolation of *Pasteurella septica* from the udder secretion of a cow. *Vet. Rec.* 51:747-748.
- Maplesden, D.C. and Carter, G.R. (1955). Bovine mastitis caused by *Pasteurella haemolytica*. A case report. *Can. J. Comp. Med.* 19:295-296.
- Messier, S., Higgins, R., Sauvageau, R. and Rovillard, J. (1981). Abortion due to *Pasteurella haemolytica* in a cow. *Can. Vet. J.* 22:91.
- Namioka, S. and Murata, M. (1961). Serological studies on *Pasteurella multocida*. III. O antigenic analysis of culture isolated from various animals. *Cornell Vet.* 51:522-528.
- Namioka, S. and Bruner, D.W. (1963). Serological studies on *Pasteurella multocida*. IV. Type distribution of the organisms on the basis of their capsule and O groups. *Cornell Vet.* 53: 41-53.
- Namioka, S. and Murata, M. (1964). Serological studies on *Pasteurella multocida*. V. Some epizootiological findings resulting from antigenic analysis. *Cornell Vet.* 54: 520-534.
- Namioka, S. (1978). *Pasteurella multocida*. Biochemical characteristics and serotypes. In: F. Bergan and J.K. Norris (Editors). *Methods in Microbiology*, Vol. 10. Academic Press, London, New York, San Francisco. 271-292.
- Neill, S.D., McCaughey, W.J., O'Brien, J.J. and Ellis, W. *Pasteurella haemolytica* in the bovine reproductive tract. *Can. Vet. J.* 22:294.
- Newsom, I.E. and Cross, T. (1932). Some bipolar organisms found in pneumonia of sheep. *J. Am. Vet. Med. Assoc.* 33:711-719.
- Nocard, M. (1927). An infectious bronchopneumonia of American oxen. Corn-stalk disease. *Vet. Rec.* 4:368-370.
- Pegram, R.G., Roeder, P.L. and Scott, J.M. (1979). Two new serotypes of *Pasteurella haemolytica* from sheep in Ethiopia. *Trop. An.H. Prod.* 11:29-30.
- Pepper, T.A., Stafford, L.P., Davies, E.T., Osbourne, A.D. and Larkin, H.A. (1968). *Pasteurella septica (multocida)* mastitis in a dairy herd. *Vet. Rec.* 83:211-215.

- Baggiardo, C.** (1981). Serological tests on bovine bacterial pneumonia. Epidemiological application and potential as a research tool. *Adv. Exp. Med. Biol.* 137:818.
- Remtulla, A.J. and Thomson, R.G.** (1981). A review of the lesion in shipping fever of cattle. *Can. Vet. J.* 22:1-8.
- Rhoades, K.R. and Rimler, R.B.** (1984). Avian pasteurellosis. In: M.S. Hofstad, H.J. Barnes, B.W. Calnek, W.M. Reid and H.W. Yoder (Editors). *Diseases of poultry*, Eighth edition. Iowa State University, Ames, Iowa. pp. 141-164.
- Roberts, R.S.** (1947). An immunological study of *Pasteurella septica*. *J. Comp. Path.* 57:261-278.
- Rose, W.K. and Rac., R.** (1957). Encephalitis in cattle due to *Pasteurella*. *Austr. Vet. J.* 33:124.
- Rosenbusch, C.T. and Merchant, I.A.** (1939). A study of the haemorrhagic septicaemia *Pasteurella*. *J. Bacter.* 37:69-89.
- Selman I.E., Allan, E.M., Dalgleish, R.G., Gibbs, H.A., Shoo, M.K. Wiseman, A. and Young, W.B.** (1986). The effect of flunixin meglumine and oxytetracycline therapy, alone and in combination, in calves with experimentally-induced pneumonic pasteurellosis. In: *Proceedings of the 14th World Congress on diseases of cattle*, Dublin, pp. 606-610.
- Shand, A. and Markson, L.M.** (1953). Bacterial meningoencephalitis in calves. *Br. Vet. J.* 109:491-495.
- Shigidi, M.T.A. and Mustafa, A.A.** (1979). Biochemical and serological studies on *Pasteurella multocida* isolated from cattle in the Sudan. *Cornell Vet.* 69:77-84.
- Shoo, M.K.** (1986). Studies on *Pasteurella* infections of the bovine respiratory tract Ph.D Thesis, University of Glasgow, 338pp.
- Shoo, M.K.** (1989). Experimental bovine pneumonic pasteurellosis. A review *Vet. Rec.* 124:141-144.
- Shoo, M.K.** (1990). Pathogenesis of bovine pneumonic pasteurellosis. *Vet. Microbiol.* (In Press).
- Smith, G.R.** (1959). Isolation of two types of *Pasteurella haemolytica* from sheep. *Nature* 183:1132-1133.
- Smith, G.R.** (1981). The characteristics of two types of *Pasteurella haemolytica* associated with different pathological conditions in sheep. *J. Path. Bact.* 81:431-440.
- Topley, W.W.C. and Wilson, G.S.** (1929). *The principles of bacteriology and immunity*, Vol. I. Edward Arnold, London.
- Tucker, E.W.** (1953). A case of natural *Pasteurella multocida* mastitis. *Cornell Vet.* 43: 378-380.
- Ward, A.C.S., Corbeil, L.B. and Evermann, J.F.** (1985). Pasteurellosis. A fatal link in bovine abortions. *Vet. Med.* 80