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## Supplement 2003–2007 (No. 47) to the White-Kauffmann-Le Minor scheme

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2 **Supplement 2003-2007 (no. 47) to the White-Kauffmann-Le Minor scheme**

3

4

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## 1 **Abstract**

2 This supplement reports the characterization of 70 new *Salmonella* serovars recognized  
3 between 2003 and 2007 by the WHO Collaborating Centre for Reference and Research on  
4 *Salmonella*: 44 were assigned to *Salmonella enterica* subspecies *enterica*, 11 to subspecies  
5 *salamae*, 5 to subspecies *arizonae*, 8 to subspecies *diarizonae*, one to subspecies *houtenae*  
6 and one to *S. bongori*. One new serovar, Mygdal, displayed a new H factor, H:z<sub>91</sub>.

7

8 *Key words*: *Salmonella*; Serovars; Taxonomy; White-Kauffmann-Le Minor scheme

9

10

## 1 **1. Introduction**

2           The genus *Salmonella* consists of only two species, *Salmonella enterica* and *S.*  
3 *bongori*. *S. enterica* is divided into six subspecies: *S. enterica* subsp. *enterica*, *S. enterica*  
4 subsp. *salamae*, *S. enterica* subsp. *arizonae*, *S. enterica* subsp. *diarizonae*, *S. enterica* subsp.  
5 *houtenae*, and *S. enterica* subsp. *indica*; and. This nomenclature reflects present  
6 understanding of *Salmonella* taxonomy [1, 4]. Serovars belonging to *S. enterica* subsp.  
7 *enterica* are typically designated by a name usually related to the geographical place where the  
8 serovar was first isolated. The serovar name is written in non-italicized Roman letters and the  
9 first letter capitalized. Serovars belonging to other subspecies are designated by their antigenic  
10 formulae, following the subspecies name. The antigenic formulae of *Salmonella* serovars are  
11 listed in a document called the White-Kauffmann-Le Minor scheme [3]. Updating this scheme  
12 is the responsibility of the WHO Collaborating Centre for Reference and Research on  
13 *Salmonella* (WHO-Salm), Institut Pasteur, Paris, France. The current edition (9th) issued in  
14 2007 comprises antigenic formulae validated as of January 1st 2007.

15           Supplement 47 reports the characterization of 70 new *Salmonella* serovars recognized  
16 between 2003 and 2007 by the WHO-Salm: 44 were assigned to *S. enterica* subsp. *enterica*,  
17 11 to subspecies *salamae*, 5 to subsp. *arizonae*, 8 to subsp. *diarizonae*, one to subspecies  
18 *houtenae*, and one to *S. bongori* (Table 1). Variants of previously described serovars are  
19 provided in Table 2. The present number of serovars per species and subspecies is given in

1 Table 3.

2 The strain 1357K (strain 9744/07) (Table 1), originally described by Kauffmann as the  
3 reference strain of *S. enterica* subsp. *enterica* serovar Hisingen (48:a:1,5,7), was recently  
4 found to be *S. enterica* subsp. *salamae* serovar 48:z<sub>81</sub>:1,5,7. Consequently the serovar  
5 Hisingen will be withdrawn in the next issue of the White-Kauffmann-Le Minor scheme.

6 Additionally, a new H factor, H:z<sub>91</sub>, was identified in one new serovar, *S. enterica* serovar  
7 Mygdal (strain 9398/03) (Table 1). A partial sequence (1250 bp) of the *fliC* gene encoding  
8 H:z<sub>91</sub> has been submitted to GenBank (accession number GQ280905). The *fliC* allele  
9 encoding H:z<sub>91</sub> was related to alleles encoding H:b. Antiserum to H:z<sub>91</sub> was prepared  
10 following WHO-Salm guidelines [2]. Briefly, rabbits were immunized using strain 9398/03.  
11 The crude antiserum (diluted 1:5) was successively absorbed with a boiled culture of strain  
12 9398/03 to remove O agglutinins. Absorbtion with formalin-treated cultures of serovar Wien  
13 strain 320K (H:b) and serovar Ohio strain CDC 1115-874/64 (H:b) were then performed to  
14 remove cross-reactions with the H:b antigen. This absorbed antiserum agglutinated only the  
15 motile culture of strain 9398/03.

16

17

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2

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4 the WHO-Salm:

5

6 **Austria :**

7 -Institut für Medizinische Mikrobiologie (IMED), Graz (C. Kornschober)

8 **Belgium :**

9 -Institut Scientifique de Santé Publique, Brussels (S. Bertrand and J.M.  
10 Collard).

11 **Canada :**

12 -National Microbiology Laboratory (NML), Winnipeg (D. Woodward and H.  
13 Tabor).

14 -Laboratory for Foodborne Zoonoses (LFZ), Guelph (A. Muckle).

15 **Denmark :**

16 -Statens Serum Institute (SSI), Copenhagen (J. Sonne-Hansen).

17 **Finland :**

18 -National Public Health Institute (NPHI), Helsinki (S. Lukinmaa and A.  
19 Siitonen).

20 **France :**

21 -Institut Pasteur (IP), Paris (F.-X. Weill and P.A.D. Grimont).

22 **Germany :**

23 -Federal Institute for Risk Assessment (BfR), Berlin (A. Schroeter and C.  
24 Dorn).

25 -Institut für Hygiene und Umwelt (IHU), Hamburg (J. Bockemühl and P.  
26 Roggentin).

27 -Robert Koch Institute (RKI), Wernigerode (W. Rabsch).

28 **Ireland :**

- 1 -National University of Ireland (NUI), Galway (N. De Lappe and M.  
2 Cormican).
- 3 **Israel :**
- 4 -Government Central Laboratories (GCL), Jerusalem (A. Reisfeld)
- 5 **New Zealand :**
- 6 -Institute of Environmental Science and Research Limited (ESR), Porirua (D.  
7 Duncan).
- 8 **Norway :**
- 9 -Norwegian Institute of Public Health (NIPH), Oslo (J. Lassen)
- 10
- 11 **Senegal:**
- 12 -Institut Pasteur de Dakar (IPD), Dakar (J.-D. Perrier-Gros-Claude and B.  
13 Garin).
- 14 **Sweden :**
- 15 -Swedish Institute for Infectious Disease Control (SIIDC), Solna (R. Wollin).
- 16 **Switzerland :**
- 17 -Institut de Bactériologie Vétérinaire (IBV), Bern (H. Hächler)
- 18 **Thailand :**
- 19 -National Institute of Health (TNIH), Nonthaburi (P. Sawanpanyalert).
- 20 **USA**
- 21 -Centers for Disease Control and Prevention (CDC), Atlanta (P.I. Fields)
- 22
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- 3 *Salmonella enterica* (ex Kauffmann and Edwards 1952) Le Minor and Popoff 1987, with
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- 15 the genus *Salmonella*, Int. J. Syst. Evol. Microbiol. 55 (2005) 521-524.
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1 **Table 1.** New *Salmonella* serovars recognized by the WHO Collaborating Centre for  
 2 Reference and Research on *Salmonella*, 2003-2007.

3

Serovar name	Antigenic formula	Other characters <sup>c</sup>	Source	Area of contamination or isolation	Year	IP strain number	Received from <sup>d</sup>
<b><i>Salmonella enterica</i></b>							
<b>subsp. enterica</b>							
Korkeasaari	28:e,h:1,5		Lizard	Africa	2003	9370/03	NPHI
Moabit	16:e,h:l,w		Melon kernel Meal	Germany	2003	9374/03	BfR
Kaevlinge	16:z <sub>4</sub> ,z <sub>24</sub> :-		Environment	Sweden	2002	9375/03	SIIDC
Mygdal	4,12:z <sub>91</sub> :-		Swine faeces	Denmark	2003	9398/03	SSI
Epalinges	43:l,w:-	01-	Environment	Switzerland	2003	9428/03	IBV
Farmingdale	43:z <sub>4</sub> ,z <sub>23</sub> :-		Lizard	USA	2003	9447/03	CDC
Amberg	6,14,24:l,v:1,7		Caraway seed	Germany	2003	9455/03	BfR
Sally	41:z:1,6		Beef meat	Senegal	2003	9460/03	IP/IPD
Evry	35:i:z <sub>6</sub>	Tar-	Human stools	France	2003	9462/03	IP
Albertbanjul	44:r:1,5	01-	Meat	Senegal	2003	9475/04	IP/IPD
Martonos	6,14,24:d:1,5		Parsley	Serbia	2004	9485/04	IHU
Gueuletapee	9,12:g,m,s:-		Chicken	Senegal	2004	9489/04	IP
Lamphun	6,8:y:1,2		Animal feed	Thailand	2003	9491/04	TNIH
Parakou	1,42:l,w:z <sub>35</sub>		Water	Africa	2004	9495/04	IHU
Hohentwiel	30:z:e,n,x,z <sub>15</sub>		Paprika powder	Germany	2004	9497/04	IHU
Carpentras	38:z <sub>35</sub> :e,n,z <sub>15</sub>		Seed	France	2004	9500/04	IP
Lund	6,8:l,v:z <sub>6</sub>		Human stools	Sweden	2003	9502/04	SIIDC
Willamette	38:d:1,5	01-	Human stools	USA	2004	9508/04	CDC
Yellowknife	9,12:r:e,n,x		Human	Canada	2004	9523/04	NML
Marsabit	52:l,w:1,5	01-	Camel	Kenya	2004	9527/04	BfR
Dingiri	17:z:1,6		Human blood	Gambia	2004	9529/04	SSI
Myrria	13,23:i:1,7		Human stools	Nigeria	2004	9544/05	NIPH
Eaubonne	18:g,s,t:-		Human stools	France	2004	9552/05	IP
Namur	39:z <sub>4</sub> ,z <sub>23</sub> :-	01-	Human stools	Belgium	2005	9585/05	IP/ISP
Lonestar	41:c:-	01-	Human stools	USA	2005	9592/05	CDC
Winslow	13,22:z:1,5	Gal+	Wild pig	USA	2005	9593/05	CDC
Salinas	40:a:1,7		Human stools	USA	2005	9596/05	CDC
Picpus	13,23:z <sub>35</sub> :1,6		Human stools	France	2005	9597/05	IP
Ivrysurseine	13,23:z:z <sub>6</sub>		Human stools	France	2005	9598/05	IP
Chennai	4,12:d:z <sub>35</sub> :-		Prawns	New Zealand	2005	9627/06	ESR
Sandaga	3,10:z <sub>38</sub> :1,2		Human stools	Senegal	2006	9647/06	IP/IPD
Umbadah	1,3,19:d:1,2		Bovine	Sudan	2006	9663/06	LFZ
Heistopdenberg	8,20:b:l,w		Human	Belgium	2006	9665/06	IP/ISP
Etobicoke <sup>a</sup>	28:d:z <sub>6</sub>	01-	Human	Canada	2006	9677/07	NML
Penzing <sup>a</sup>	35:k:e,n,z <sub>15</sub>	01-	Human	Austria	2005	9697/07	IMED
Portedeslilas <sup>a</sup>	1,42:l,v:1,6,7	Dul-	Human blood	France	2007	9700/07	IP
Neuland <sup>a</sup>	16:z <sub>35</sub> :1,5		Plant environment	Germany	2007	9713/07	IHU
Boston <sup>a</sup>	13,23:c:e,n,z <sub>15</sub>		Human stools	USA	2007	9716/07	CDC
Leinster <sup>a</sup>	45:b:1,6		Human	Nigeria	2000	9721/07	NUI
Galway <sup>a</sup>	13,23:k:e,n,z <sub>15</sub>		Human	Nigeria	2007	9722/07	NUI
Ulm <sup>a</sup>	1,6,14,25:z <sub>10</sub> :z <sub>6</sub>		Sesame seed	Germany	2007	9743/07	IHU

Darfur <sup>a</sup>	43:z <sub>41</sub> :1,2		Human	Tchad	2007	9748/07	RKI
Miromesnil <sup>a</sup>	1,3,19:z <sub>4</sub> ,z <sub>23</sub> :-		Human stools	France	2007	9758/07	IP
Serenli <sup>a</sup>	1,13,23:z:1,5		Human stools	Africa	2006	9759/07	NIPH
<b>subsp. <i>salamae</i></b>							
	48:z <sub>39</sub> :z <sub>81</sub>	Gel-, Sal+	Human stools	USA	2003	9505/04	CDC
	6,7:z <sub>4</sub> ,z <sub>23</sub> :-	01-,ONPG+	Human	Canada	2004	9521/04	NML
	40:m,t:e,n,x	01-	Beef	Namibia	2002	9539/05	NIPH
	40:l,z <sub>28</sub> :e,n,x		Beef	Namibia	2002	9540/05	NIPH
	28:m,t:z <sub>39</sub>		Meat	Namibia	2003	9543/05	NIPH
	40:z <sub>10</sub> :e,n,x	ONPG+	Chameleon	Germany	2005	9583/05	BfR
	17:d :- <sup>a</sup>		Beef	Africa	2006	9669/06	NIPH
	60:z <sub>10</sub> :z <sub>39</sub> <sup>a</sup>	Gel-	Human stools	USA	2007	9714/07	CDC
	6,7:z <sub>38</sub> :e,n,x <sup>a</sup>		Human stools	Mozambique	2007	9733/07	NPHI
	48:z <sub>81</sub> :1,5,7 <sup>a,b</sup>	Gel-	Fish meal	Angola	1961	9744/07	IP/IHU
	9,46:l,w:e,n,x <sup>a</sup>		Beef	Namibia	2006	9760/07	NIPH
<b>subsp. <i>arizonae</i></b>							
	48:z <sub>29</sub> :-		Human stools	USA	2002	9379/03	CDC
	45:z <sub>36</sub> :-		Snake	USA	2003	9464/03	CDC
	21:z <sub>36</sub> :-		Human stools	USA	2005	9595/05	CDC
	50:g,z <sub>51</sub> :-	GGT+	Human stools	USA	2005	9628/06	CDC
	18:z <sub>36</sub> :- <sup>a</sup>		Human blood	USA	2006	9715/07	CDC
<b>subsp. <i>diarizonae</i></b>							
	48:z <sub>4</sub> ,z <sub>24</sub> :-	Muc+, Glu-	Snake	Switzerland	2002	9407/03	UVB
	8:k:z <sub>35</sub>	GGT-, Mal-	Avian	USA	2003	9446/03	CDC
	52:k:e,n,x,z <sub>15</sub>		Water	France	2003	9453/03	IP
	63:(k):z		Snake	USA	2003	9488/04	CDC
	43:g,t:-	Muc+, Glu-	Human stools	Sweden	2004	9504/04	SIIDC
	8:r:z	Glu-, Gel-	Human stools	USA	2003	9507/04	CDC
	50:i:z <sub>53</sub>	Muc+, Tar+	Chameleon	Germany	2005	9604/05	BfR
	65:i:z	Muc+	Reptile	Germany	2006	9648/06	BfR
<b>subsp. <i>houtenae</i></b>							
	18:g,z <sub>51</sub> :-		Human	USA	2006	9654/06	CDC
<b><i>Salmonella bongori</i></b>							
	1,9,12:d:e,n,x <sup>a</sup>		Cattle	Finland		9736/07	NPHI

1 <sup>a</sup>Serovar name or antigenic formula not recorded in the current (9th) edition of the White-Kauffmann-Le  
2 Minor scheme.

3 <sup>b</sup>Corresponds to Kauffmann's strain 1357K, originally described as the reference strain of *S. enterica*  
4 subsp. *enterica* serovar Hisingen (48:a:1,5,7).

5 <sup>c</sup>The differential phenotypical characters of *Salmonella* species and subspecies are indicated in  
6 reference 3. Only the atypical results are mentioned. Tests used :  $\beta$ -galactosidase, ONPG ;  $\beta$ -  
7 glucuronidase, GLU ; gelatinase, Gel ; galacturonate, Gal ; malonate, Mal ; salicin, Sal ; dulcitol,  
8 Dul ; mucate, Muc ; L(+) tartrate (= *d*-tartrate), Tar ;  $\gamma$ -glutamyltransferase, GGT ; lyse by phage O1,  
9 O1. +, positive reaction ; -, negative reaction.

10 <sup>d</sup>The National Reference Centres having sent the isolates are indicated in the acknowledgments section.

1 **Table 2.** New variants of previously described *Salmonella* serovars recognized by the WHO Collaborating Centre for Reference and Research on  
 2 *Salmonella*, 2003-2007.

3

IP strain number	Antigenic formula	Other characters <sup>a</sup>	Source	Area of contamination or isolation	Year	Received from <sup>b</sup>	Serovar name	Updated antigenic formula
<b><i>S. enterica</i> subsp. <i>enterica</i></b>								
9429/03	43:l,w:z <sub>44</sub>	01-	Human	Switzerland	2003	UVB	Epalinges	43:l,w:[z <sub>44</sub> ]
9445/03	4,12:g,m,s:1,2	Tar-	Turkey	USA	2003	CDC	Hato	<u>1</u> ,4,[5],12:g,m,s:[1,2]
9450/03	{6,7,14} {54}:g,m,s:-		Calf meat	Germany	2003	IHU	Montevideo	{6,7, <u>14</u> } {54}:g,m,[p],s:[1,2,7]
9467/03	1,4,12:i:e,n,z <sub>15</sub>		Human stools	France	2003	IP	Tsevie	<u>1</u> ,4,12:i:e,n,z <sub>15</sub>
9549/05	43:z <sub>4</sub> ,z <sub>23</sub> :1,2		Human stools	Norway	2004	NIPH	Farmingdale	43:z <sub>4</sub> ,z <sub>23</sub> :[1,2]
9554/05	1,4,12:e,h:e,n,z <sub>15</sub>		Sunflower kernels	Germany	2004	IHU	Sandiego	<u>1</u> ,4,[5],12:e,h:e,n,z <sub>15</sub>
9645/06	1,4,12:r:e,n,z <sub>15</sub>		Cattle	Sudan	2006	LFZ	Drogana	<u>1</u> ,4,12,[27]:r,[i]:e,n,z <sub>15</sub>
9658/06	1,4,12:r:l,w		Human stools	France	2006	IP	Bochum	<u>1</u> ,4,[5],12:r:l,w
9717/07	4,5,12:b:1,5	Muc-	Human stools	USA	2006	CDC	Limete	<u>1</u> ,4,[5],12:b:1,5 <sup>c</sup>
9740/07	42:l,v:1,6,7	Dul-	Human stools	Finland	2007	NPHI	Portedeslilas	<u>1</u> ,42:l,v:1,6,7 <sup>c</sup>
9742/07	1,13,23:d:l		Human stools	France	2007	IP	Putten	<u>1</u> ,13,23:d:l,w <sup>c</sup>
9752/07	1,4,12,27:l,v:1,5 <sup>a</sup>		Human stools	France	2007	IP	Azteca	<u>1</u> ,4,[5],12,[27]:l,v:1,5 <sup>c</sup>
<b><i>S. enterica</i> subsp. <i>salamae</i></b>								
9383/03	4,5,12:b:-		Turtle faeces	Germany	2003	BfR		1,4,[5],12,[27]:b:[e,n,x]
<b><i>S. enterica</i> subsp. <i>diarizonae</i></b>								
9469/03	1,40:l,v:z <sub>53</sub>		Human	Israel	2003	GCL		<u>1</u> ,40:l,v:z <sub>53</sub>
<b><i>S. enterica</i> subsp. <i>indica</i></b>								
9437/03	6,14:a:e,n,x	01-	Environment	Switzerland	2003	UVB		[1],6,14,[25]:a:e,n,x

4

5 <sup>a</sup>The differential phenotypical characters of *Salmonella* species and subspecies are indicated in reference 3. Only the atypical results are mentioned. Tests  
 6 used : dulcitol, Dul ; mucate, Muc ; L(+) tartrate (= *d*-tartrate), Tar; lyse by phage O1, O1. +, positive reaction ; -, negative reaction.

7 <sup>b</sup>The National Reference Centres having sent the isolates are indicated in the acknowledgments section.

8 <sup>c</sup>Antigenic formula not recorded or not updated in the current (9th) edition of the White-Kauffmann-Le Minor scheme.

1 **Table 3.** Present number of serovars in each species and subspecies of *Salmonella*.  
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4	<i>S. enterica</i>	
5	subsp. <i>enterica</i>	1547
6	subsp. <i>salamae</i>	513
7	subsp. <i>arizonae</i>	100
8	subsp. <i>diarizonae</i>	341
9	subsp. <i>houtenae</i>	73
10	subsp. <i>indica</i>	13
11		
12	<i>S. bongori</i>	23
13		
14	Total	2 610

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